MACHINERY

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WORK HOLDING ARBORS AND METHODS FOR TURNING OPERATIONS

A TYPICAL COLLECTION OF DEVICES ESPECIALLY DESIGNED FOR HOLDING WORK IN THE FAY AUTOMATIC LATHE

THE developments in the design of machine tools during the last ten or fifteen years have brought these machines to a high degree of perfection. Many are provided with features which make great precision possible, and a workman who understands how to get the most out of one of these modern machine tools can produce very accurate work. It should be remembered, however, that no matter how accurate and how well adapted to rapid production the machine may be, if the methods of holding the work are not equally well thought out there is comparatively little gained. As a matter of fact, this point is neglected in a great many machine shops. In a few instances, we find planning departments and efficient tool-designing departments where the methods and appliances to be used in manufacturing are carefully considered. In the majority of shops, however, the workmen, or at best the foremen, are left to devise for themselves the methods by which the work is to be held in the machines. In the few cases where the workman is unusually ingenious, this may be of advantage, but it is seldom possible for the man at the machine to consider both the accuracy required and the rapidity of production with anything like the care that can be done by a designer especially detailed to do this work.

Therefore, it is becoming generally recognized that in order to take advantage of the full capacity and adaptability of modern machine tools, it is necessary that the work-holding and machining methods be worked out by designers of equal ability to those who actually design the machine. In the following article a few methods will be shown for holding different classes of work for turning and facing operations in the lathe. The arbors and devices shown were designed under the direction of Mr. Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt., for use in the Fay automatic lathe; but as far as the methods for holding the work are concerned, they may be employed with equal advantage in any engine lathe, and are therefore capable of wide application. The tooling arrangements shown in each case are, of course, especially adapted to the Fay automatic lathe with its front and rear tool-holders, but by means of a special tool-block many engine lathes could be rigged up to perform the work in a similar manner. These tooling arrangements will probably suggest other machining methods.

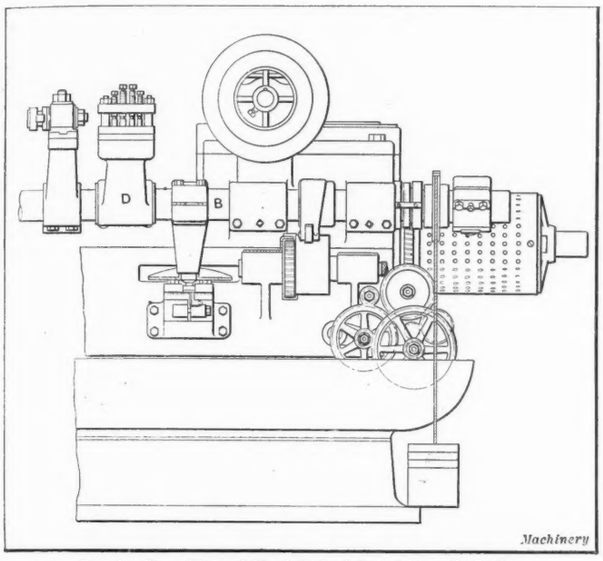

Fig. 1. Rear View of Head End of Fay Automatic Lathe

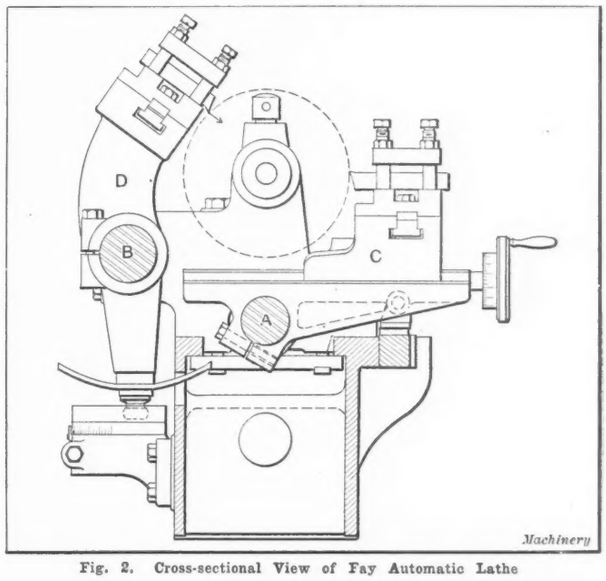

Fig. 2. Cross-sectional View of Fay Automatic Lathe

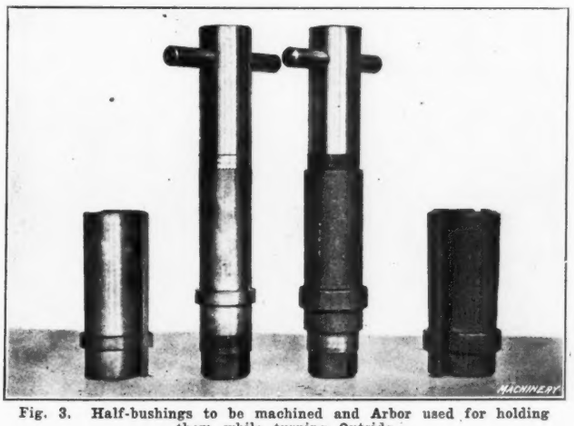

Fig. 3. Half-bushings to be machined and Arbor used for holding them while turning Outside

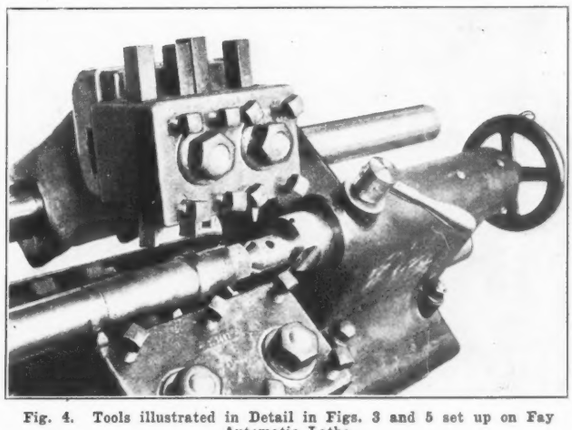

Fig. 4. Tools illustrated in Detail in Figs. 3 and 5 set up on Fay Automatic Lathe

Principles of Arrangement of the Fay Automatic Lathe

In order to make the following article intelligible in so far as the arrangement of the tools is concerned, it will be necessary to refer briefly to the construction of the Fay automatic lathe. (A general description of this machine was published in the June, 1909, number of MACHINERY.) The line engraving Fig. 1 shows a rear view of the head end of the machine; Fig. 2 shows a sectional view. The main or work-spindle is driven by worm gearing from a cone pulley mounted at right angles to it. A series of cams is provided for controlling the cutting tools, and by means of a clutch mechanism operated by adjustable dogs, the cam-shaft may be given a slow feeding movement or a rapid idle movement over any portion of the periphery of the cam. Two heavy bars, *A* and *B*, extend the full length of the machine and on these the various carriages and tool-holders are mounted. Each of these bars is controlled by a cam both as regards the longitudinal and the rocking movement about their axes. The rocking movement of the front tool-holder *C* is caused by templets or cam surfaces on the slide or former bar at the front of the bed on which the outer end of the carriage rests. These templets may be given any desired shape which will be copied by the tool as the carriage is fed longitudinally. The carriage may also be held stationary and the former bar carrying the templet may be fed to the right or left, thereby causing the tool to feed directly in or out at right angles to the axis of the work. The main tool bar is operated longitudinally by an internal cam surface within the cam drum shown to the right in Fig. 1, and the tool slide at the rear is rocked by a cam beneath the headstock. It will be understood from this description that the front tool-block *C* is especially adapted to straight turning, taper turning and forming operations, while the rear tool-holder *D* is intended for operations requiring the tool to be fed in toward the center of the work after which, of course, the tool-bar can be fed longitudinally for ordinary straight turning operations.

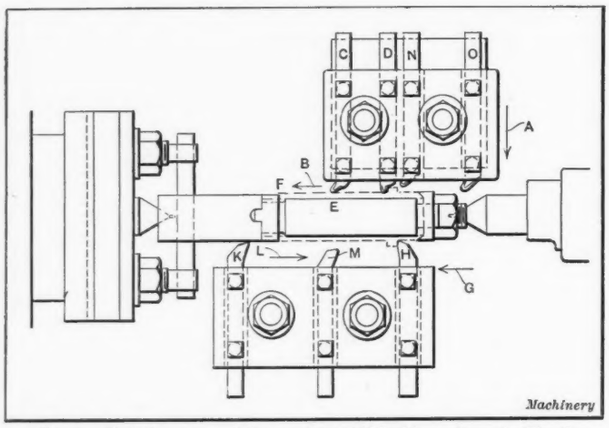

Fig. 5. Tool Arrangement for turning Half-bushings shown in Fig. 3

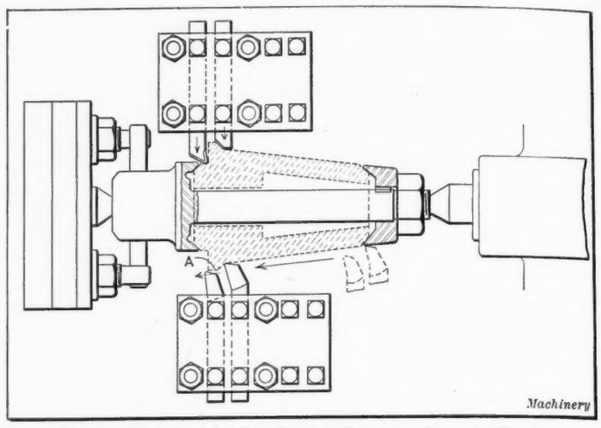

Fig. 6. Method of holding Tapered Bushings shown in Fig. 7

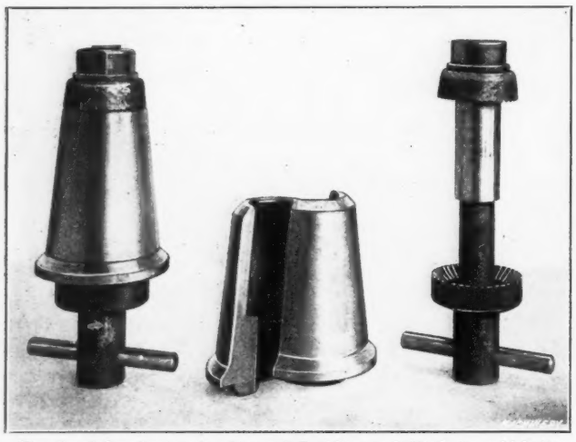

Fig. 7. Arbor for turning Tapered Bushings and Work for which it was designed

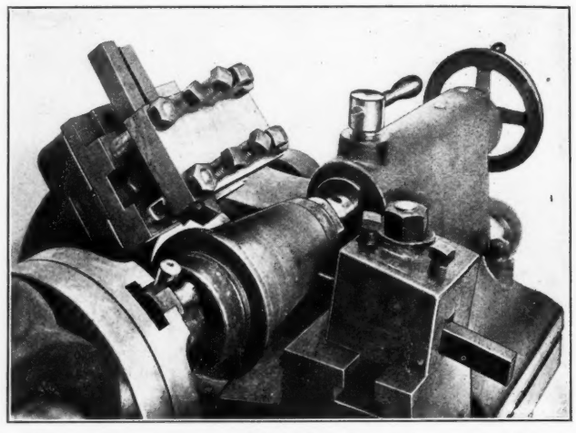

Fig. 8. Tools shown in Detail in Figs. 6 and 7, set up on Fay Automatic Lathe

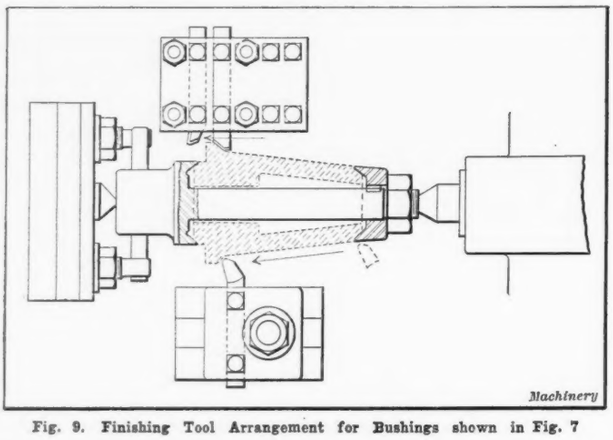

Fig. 9. Finishing Tool Arrangement for Bushings shown in Fig. 7

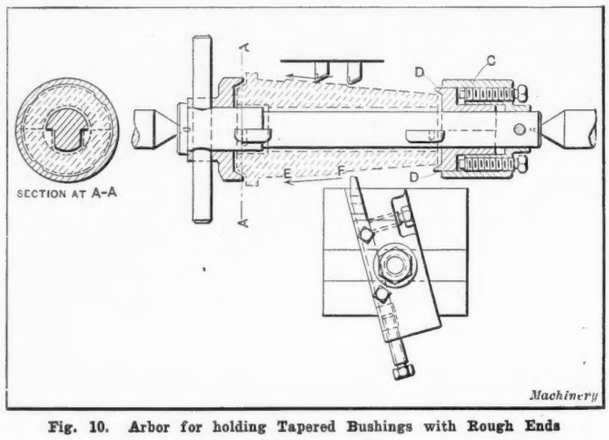

Fig. 10. Arbor for holding Tapered Bushings with Rough Ends

Arbors for Holding Bushings made in Halves

The arbor shown in Fig. 3 is used for holding the type of half-bushings illustrated while turning the outside. When performing this operation, it is necessary that the bushings be so held that the parting line comes exactly in the center, so that the two halves are interchangeable. At the same time, they must be held so that the outside will be true with the inside, which has already been finished by a formed convex milling cutter. When the inside has been finished, the two halves are clamped to an arbor and the ends are finished to a beveled surface by a hollow mill. The half-bushings are then ready to be placed on the arbor shown in Figs. 3 and 5, where they are held in place by beveled collars slightly corrugated on the tapered surfaces to form an effective drive. By holding the bushings in this manner the whole of the outside can be finished at one setting. The rear tool-block carries the roughing tools and is first fed inward in the direction of arrow *A*, Fig. 5, and then to the left in the direction of arrow *B*. The roughing cut is divided

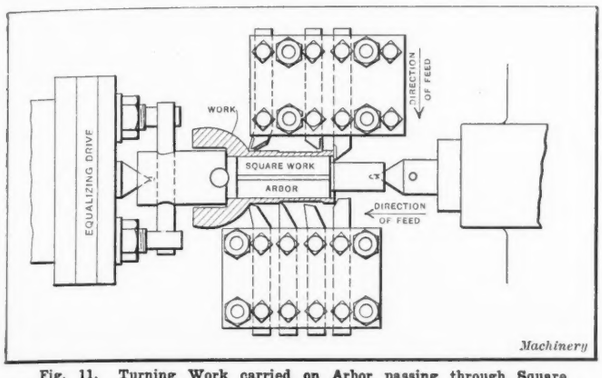

Fig. 11. Turning Work carried on Arbor passing through Square Broached Hole

between the tools *C*, *D*, *N*, and *O*, so that the tool slide needs to feed from *E* to *F* only in order to complete the roughing cut. The tool *N* roughs out the top of the shoulder on the bushing, while the tool *O* roughs out the part of the bushing to the right of the shoulder.

The finishing tools are held in the front tool-holder. Tool *H* is first fed in the direction of arrow *G*, finishing one end of the bushing, and then tool *K* is fed in the direction of arrow *L* to finish the other end of the bushing; at the same time, tool *M* finishes the collar or shoulder shown. The roughing is entirely completed before the finishing cut begins. The finishing cut on the long surface to the left on the

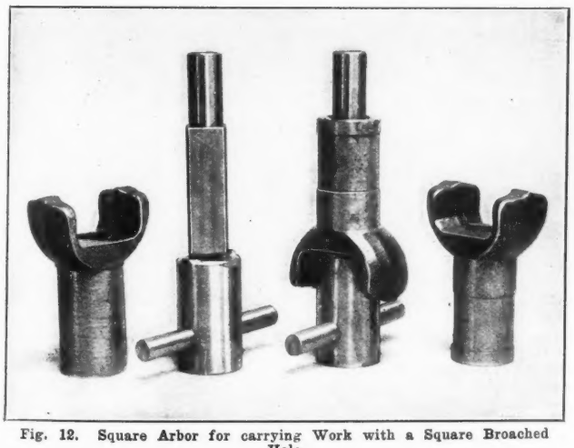

Fig. 12. Square Arbor for carrying Work with a Square Broached Hole

bushing is done by one tool *K* and not by two tools as in the case of the roughing cut, because if two tools were used for finishing it would be difficult to avoid a slight mark on the turned surface at the point where the two cuts meet. Fig. 4 shows the work and tools as arranged in the machine.

In Fig. 6 is shown an arbor used for holding a tapered bushing while finishing the outside; the bushing is shown in Fig. 7, and Fig. 8 shows the work and tools set up in the machine. In this case the hole in the bushing, which is made in halves as in the preceding case, is rough. The joint between the two halves must, however, come exactly in the center of the finished bushing so that the two halves may be interchangeable. The first operation is to plane the joints; then the two halves are clamped together and the ends are finished by a hollow mill to form a bevel bearing for the clamping collars of the arbor. When milling the ends, the joint must be held central in a jig especially designed for the purpose. The half-bushing is then clamped on the arbor shown in Fig. 7, the beveled surfaces of the collar and shoulder holding it true. Fig. 6 shows the arrangement of the roughing tools, the arrows indicating the direction in which they are fed. The front and rear tools are in action simultaneously. The front tools are guided by a taper former on the former bar. In the roughing operation the small surface at *A* will, of course, be turned on a taper, but this will be corrected by the finishing operation, the tooling arrangement for which is shown in Fig. 9. In this case the tools in the back tool-holder finish the short taper on the shoulder and

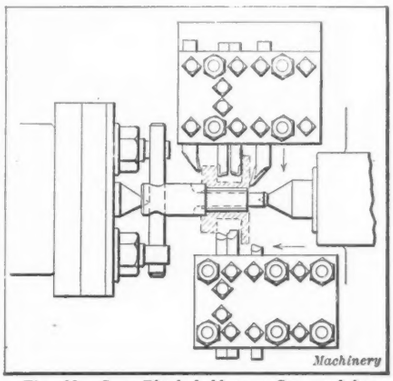

Fig. 13. Gear Blank held on a Square Arbor

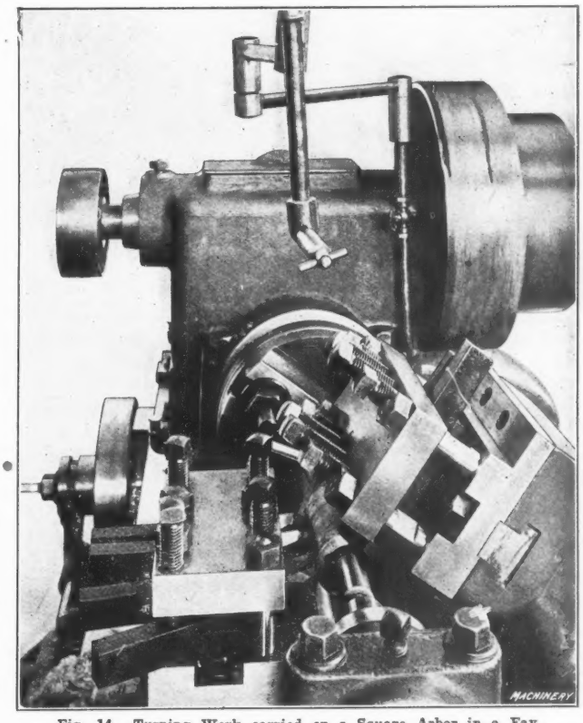

Fig. 14. Turning Work carried on a Square Arbor in a Fay Automatic Lathe

the top of the projection. The long taper surface of the bushing is finished by the tool held in the front tool-holder. Arrangements are made for relieving the tool on the return.

Fig. 10 shows another tapered bushing made in halves, which is turned on the outside before the inside is finished. Here the ends are not finished because other means are available for holding the work so as to locate the joint in the center of the finished bushing. There are lugs on the inside of one of the half-bushings, which bear against shoulders on the arbor, as shown by the section to the left. After the two halves are finished by planing, the half provided with the lugs is first placed on the arbor so that the lugs bear against these shoulders, which insures a correct location. As the ends are rough, the clamping arrangements must be made to

take care of any adjustment necessary to provide a full bearing. A bushing *C* is therefore provided within which slide two half-bushings *D*, operated by adjusting screws. By means of these screws each half of the bushing to be turned

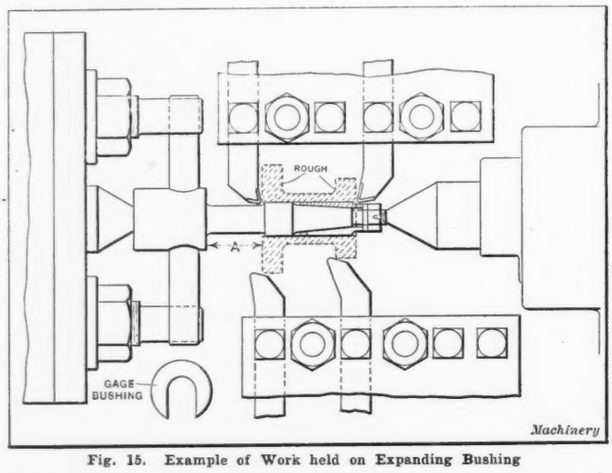

Fig. 15. Example of Work held on Expanding Bushing

can be clamped tightly against the collar at the other end of the arbor; at the same time the joint in the center will be held in correct relation to the center of the arbor. The roughing cut is divided between the two tools in the rear tool-

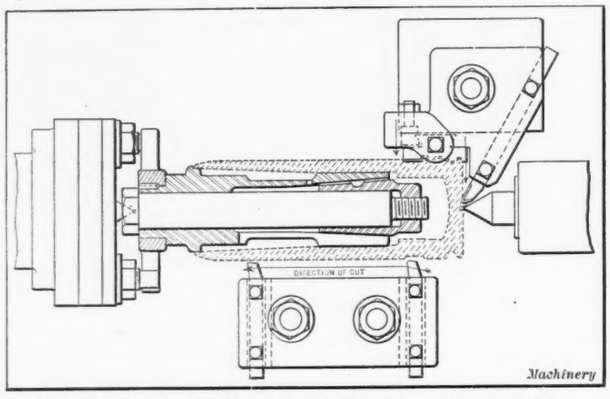

Fig. 17. Combination Threaded and Expanding Arbor for holding Shrapnel Shell in Lathe

holder and the finishing is done by the tool in the front toolholder. Only the short surface from *E* to *F* is finished.

Holding Work with Square Holes

A piece of work with a square broached hole by which the

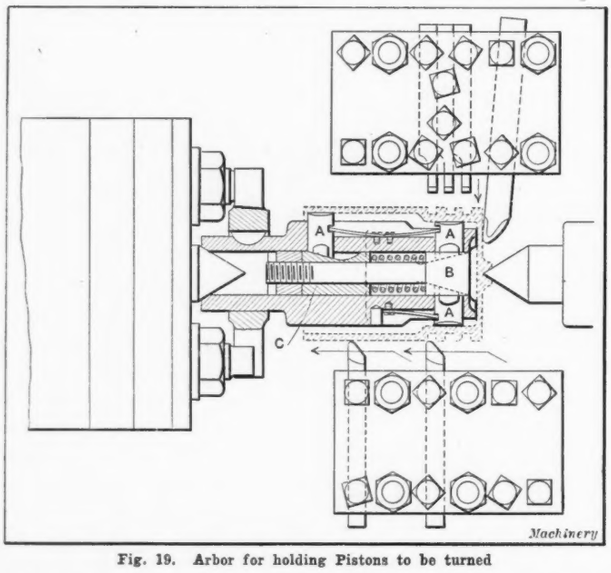

Fig. 19. Arbor for holding Pistons to be turned

piece is held on a square arbor is shown in Fig. 11. In this case the cutting is all done in one direction so that it is unnecessary to provide for clamping the work for endwise motion. An illustration of the piece of work and the arbor, also showing the work in place on the arbor, is given in Fig. 12. The tools, as inserted in their respective holders, are shown in place on the machine in Fig. 14.

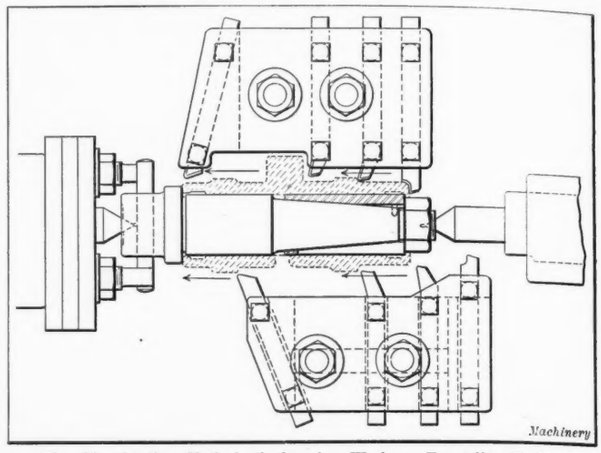

Fig. 16. Another Method of clamping Work on Expanding Bushing

Fig. 13 shows a simple method for holding a gear blank with a square hole. The hole in the blank is first bored, after which the piece is roughed all over except on the large diameter and on the face next to it, as it is held by these

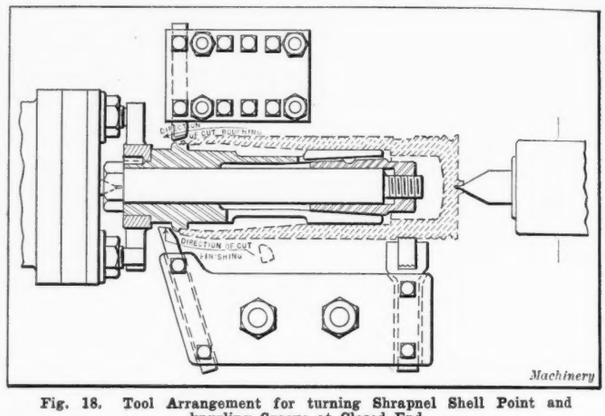

Fig. 18. Tool Arrangement for turning Shrapnel Shell Point and knurling Groove at Closed End

surfaces in the turret lathe. Then the hole is broached, two keyways being provided at the same time, after which the piece is placed on the arbor, the keys being driven in just tight enough to hold it in place. The tooling arrangement

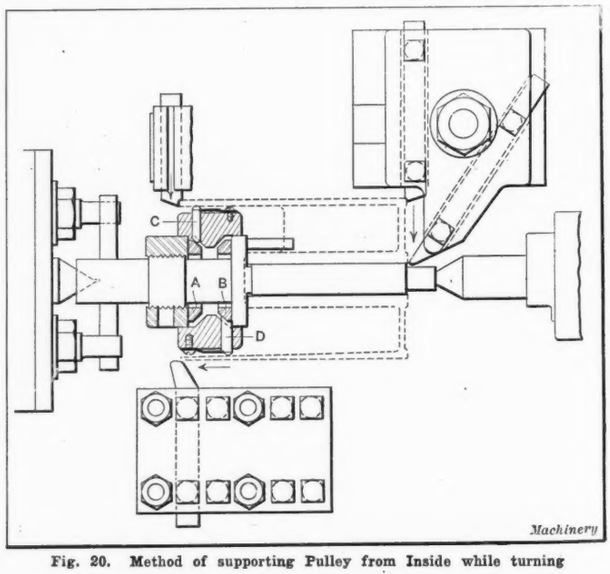

Fig. 20. Method of supporting Pulley from Inside while turning

used for finishing the surfaces is shown in the illustration.

When a piece of work is to be finished on the Fay automatic lathe, or in any lathe with multiple tools and fixed stops,

it is necessary that the endwise location of the work be always the same; hence when work with a round hole is to be finished, it cannot be held on an ordinary arbor with a slight taper unless the hole is so accurately finished that the piece will come to a driving fit at a given place on the arbor, in which case the point to which the work is to be driven

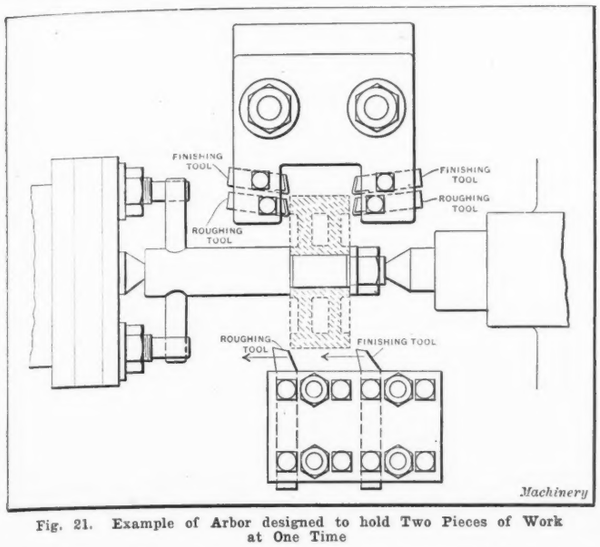

Fig. 21. Example of Arbor designed to hold Two Pieces of Work at One Time

may be determined by means of a simple gage which acts as a stop. As a matter of fact, some firms make it a point to machine the holes in work of this kind so accurately that the work can be driven onto an arbor and come to a driving fit at a given point. This can almost always be done with bronze bushings, as there is enough elasticity in this material to permit the pieces to be forced down to a certain

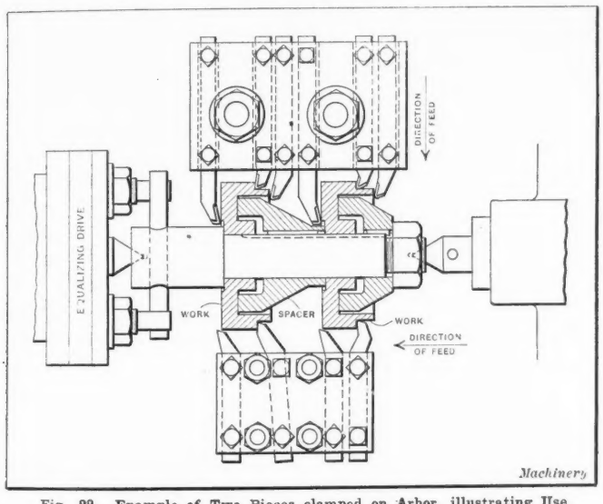

Fig. 22. Example of Two Pieces clamped on Arbor, illustrating Use of Spacer

position. With this method of holding, both ends of the work can be faced, as there are no clamping arrangements to obstruct the path of the tools.

Holding Work by Means of Expanding Bushings

One of the simplest methods for holding work with a finished hole is by means of expanding bushings. This method makes it possible to chuck the hole in a drill press and still hold it at a given position on an arbor without obstructing the ends of the work, and in such a way that both ends of the work can be faced. In the case shown in Fig. 15 the hole was too long to fit a split bushing the entire length, as the thickness of the bushing would have been rather excessive at one end, or else the taper would have had to be made too small; therefore part of the arbor is turned straight and to fit the hole in the gear blank to be turned. In order to insure that the piece be placed in the same position longitudinally each time, a gage bushing, an end view of which is shown in the lower left-hand corner of the illustration, is used to gage distance *A*. The piece of work is dropped onto the arbor and secured loosely against the gage; then the gage is withdrawn and the nut is tightened to hold the work firmly in place. The arrangement of the tools for finishing this piece is clearly indicated in the illustration.

In Fig. 16 is shown another example of an arbor for clamping work by means of a split bushing. The work here shown is an armature bearing box. No gage is necessary in this case, as the work is located by a shoulder at one end of the arbor, only one end of the work being faced off. The roughing is done by the tools in the rear tool-holder and the finishing by the tools in the front holder. Another interesting method of holding work while machining is shown in Fig. 17. The work here shown in position on the arbor is a shrapnel shell. The work is threaded on the inside at one end and can thus be screwed onto a threaded portion of the arbor. The end of the arbor is split and provided with an expander. The rear tool slide holds the roughing tool which

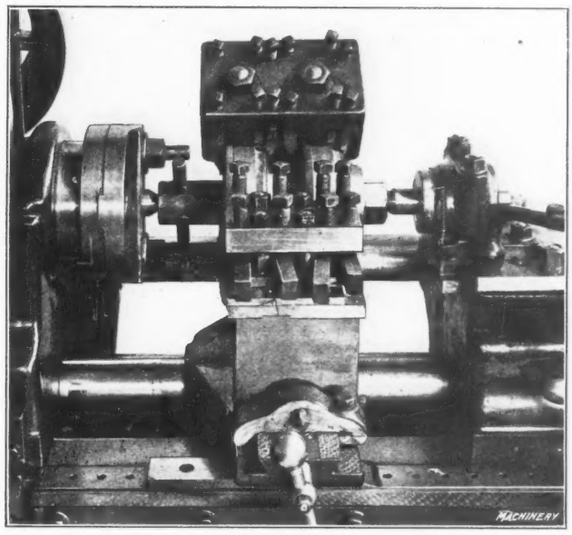

Fig. 23. Two Pieces of Work on Arbor mounted in Fay Automatic Lathe

faces the end, and also a forming tool which comes into a surface free from scale that has been roughed off by one of the tools in the front slide. The direction of the cut of the tools in the front slide, first inward, then parallel, and then slightly outward, is shown by the arrow. Fig. 18 shows

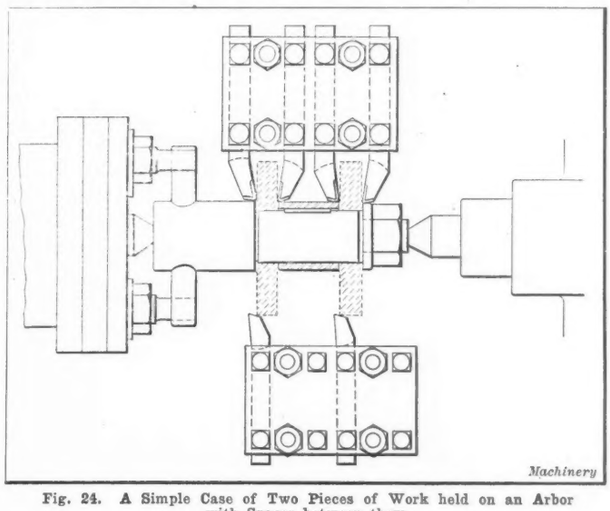

Fig. 24. A Simple Case of Two Pieces of Work held on an Arbor with Spacer between them

the arrangement of the tools for roughing and finishing the tapered end of the shell and for knurling a groove at the closed end. In this case a special grooved former must be used in place of the taper attachment of the machine at the rear. When the front tool at the left has completed its cut the finishing tool-holder drops in, permitting the tool to the

right to perform the knurling operation. In this case a former is clamped to the former bar of the machine.

Supporting Thin Work from the Inside

The most interesting holders for work that is to be machined in the lathe are, perhaps, those that are arranged to support thin work from the inside. In Fig. 19 is shown one example of a piston held by an equalizing arrangement. This arrangement is applicable only to pistons which are not to be ground. The usual method is to bore a hole for a short distance inward at the end of the piston and then drill the wrist-pin hole. The bored portion is used for locating the work in position by means of a stud through the wrist-pin. The method shown in the present illustration, however, permits the work to be done in one operation without any counterboring, and with the assurance of an even thickness of metal all around the piston. One end of the piston is centered in a centering machine. If the piston is heavy it may be held by the outside during this operation. If the metal is thin, it is preferable to center it with reference to the inside, holding the work in a jig like the fixture used in the machine. The holding device consists of three plungers *A* at each end of the piston, which slide in slots cut in the head of bolt *B* and in collar *C*, and which thus both center the work and support it on the inside. In the case of small pistons only two plungers are used at the closed end, because

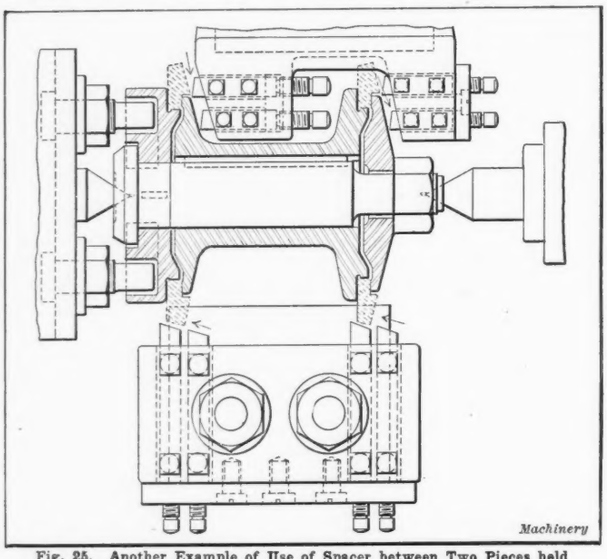

Fig. 25. Another Example of Use of Spacer between Two Pieces held on the Same Arbor

there is not enough room for three on account of the bosses for the wrist-pin. The bolt with the tapered slot is tightened by means of a nut having a slot in it, which can be reached from the end of the arbor when the fixture is taken out of the machine, by means of a special screwdriver. The tooling arrangement shown in the illustration is that provided for roughing the piston. The two tools in the front holder divide the roughing cut between them so that the feed motion needs to be only one-half of the length of the piston.

Fig. 20 shows a method used for supporting the overhanging rim of a long pulley. In this case the pulley is centered by the hole which fits the arbor, and the support must simply act as an equalizer. As will be seen, two floating collars, *A* and *B* are provided which are tapered on one side. This tapered side bears against pins *C* and *D*. As the collars are perfectly free to locate themselves with relation to the arbor, it is evident that the pressure on the pins (of which there are three for each collar) will be the same, and there will be no tendency to throw the work out of center, but to merely support it with equal pressure at the six bearing points.

Holders for Two Pieces of Work

In many instances it is possible to hold two pieces on the same arbor, thus practically cutting the time of machining in half. The simplest illustration of this is probably that shown in Fig. 21, where two gear blanks which have been faced on one side and have had the holes bored, are clamped together and faced on the other side and turned on the outside. The arrangement of the tools is of interest; the arrows shown give the direction of the feed and indicate the method of procedure. Fig. 22 shows another case where two pieces held on the same arbor are machined at the same time. A spacer is provided between the two pieces so as to locate the one to the right in position, the one to the left being located against a shoulder on the arbor. In order to use this arrangement for location, it is necessary for the work to have shoulders finished on two sides and also that the finishing be done accurately enough so that it can be used for locating

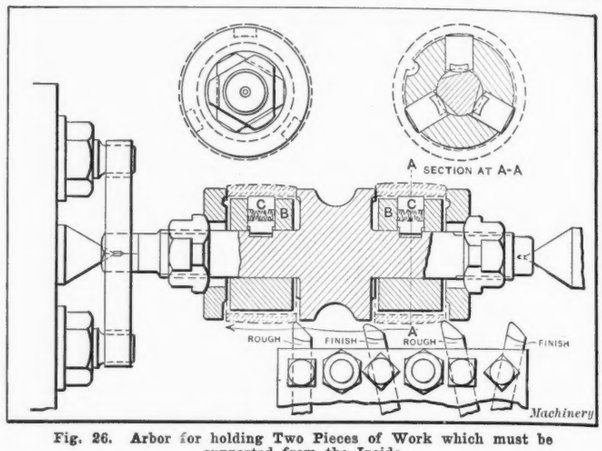

Fig. 26. Arbor for holding Two Pieces of Work which must be supported from the Inside

the two pieces. In this case both the clamping collar and the spacer are keyed to the arbor to make the drive more positive. In Fig. 23 this job is shown set up in the machine.

In Fig. 24 is shown another case of clamping two pieces using a spacer between them. It is evident that if the two sides of the hubs of the gear blanks had not previously been machined, this method could not be used as the gear blank to the right would not come in an accurate position to permit being machined by the tooling arrangement indicated.

In Fig. 25 is shown still another example of holding two pieces by means of a spacer. Here the roughing and finishing are done at the same time. The tools in the rear and front holders operate simultaneously, the taper attachment being used for the rear holder. A taper former is used on the former bar for the front tool-holder. Fig. 26 shows an especially interesting arrangement for holding two pieces and for sup-

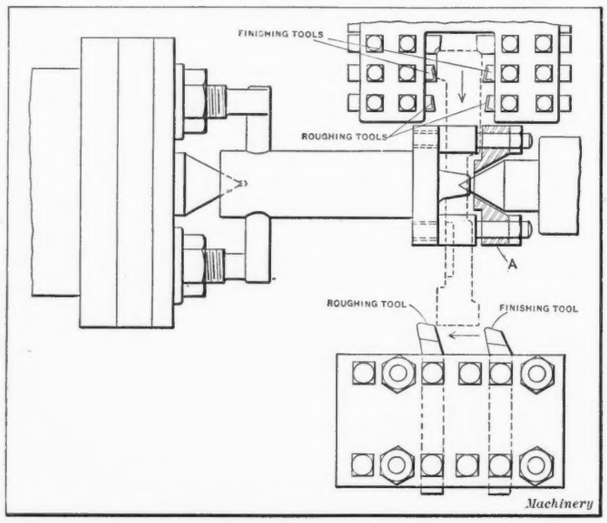

Fig. 27. Arbor for holding Small Flywheel while machining the Rim

porting the thin walls of the bushings while machining. In this case the ends and the inside of the bushing are rough. The only difficulty that was met with was to machine them without distorting them on account of the thinness of the metal. The bushings are both centered and supported by the rough inside surface. For this purpose bushings *B* are provided on the arbor. These bushings hold plugs *C* which are prevented from falling out of their seats by springs

when the pieces to be machined are to be removed from the arbor. The arbor itself is provided with three flat spots or bearings, as shown in the sectional view at the top. These act as cam surfaces when the arbor is turned and force the plugs outward, thereby centering and supporting the work on the inside. This arbor shows a different method than those shown in the previous examples for holding two pieces at once. Here the middle portion of the arbor is solid and provided with three bearing points on each side for the work. Then collars are provided at each end of the arbor with nuts for clamping the work. One disadvantage is present with this arbor. The dog at the driving end must be removed to take off the pieces nearest to the head. In practically all the other cases shown a driving pin driven into the arbor can be used, as the work is removed in the other direction.

Method of Holding a Narrow Flywheel

Fig. 27 shows an interesting method for holding a narrow flywheel for a motorcycle while machining the sides and the face. It is necessary to hold this piece in such a manner that it is not thrown out of true sidewise. At the same time the sides of the rim must be left partially free for machining. The difficulty of holding the rim true is due to the fact that the hole in the wheel is very short and provided with a short taper. If an arbor is made which projects through, it will be so small in diameter that it is likely to break off under a heavy cut, particularly if threaded on the end. The method by means of which this difficulty was overcome is shown in the illustration. The arbor is made with a projecting tapered end into which the tail center enters, and an equalizing collar *A* is provided which presses the wheel onto the tapered end of the arbor. One of the studs by means of which the equalizing collar is held against the end of the shoulder of the arbor acts as a drive for the flywheel by bearing against a central fin of the drop-forging. The studs pass through openings in the web of the wheel.

These examples indicate in a general way the various types of holding devices that are likely to be required in turning operations. While they do not cover special cases, they show principles that can generally be applied. It is apparent that if devices of this kind were more generally provided, the full advantage of the facilities offered by modern machine tools could be better realized. In cases of interchangeable manufacture, the arbors and methods of arranging the tools and operations can hardly be left to the decision of each individual workman, as there is much to be gained by a thorough study of the subject by those who give their entire attention to work of this character. E. O.

* * *

ADJUSTABLE FIXTURE FOR HOLDING IRREGULAR SHAPED WORK

Irregular shaped castings which must be machined, often present no apparently good means of holding by ordinary gripping appliances for drilling, shaping or milling. An example is the casting indicated at *A* in Fig. 1. Mr. John Bolard, general foreman of the Hall Printing Press Co.'s factory at Dunellen, N. J., has designed an adjustable fixture for holding such work, and two of these are shown strapped on the milling machine table in Fig. 1. The fixture consists of a base block *B*, which is T-slotted, three slots radiating from a central point. In each of these slots is fitted a gripping dog, illustrated in detail in Fig. 2. The base block *C* of the dog is slotted to receive jaw *D*, which is fulcrumed on a cross-pin. In the tail of the dog is threaded a set-screw *E*, and by turning in this set-screw the jaw is caused to "bite" inward and downward at the same time, firmly gripping the casting and forcing it down on the table. A back-stop *F* is bolted behind each dog so that there is no chance for slipping away from the work.

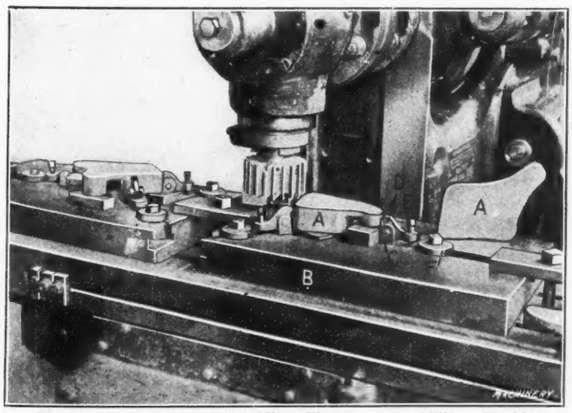

Fig. 1. Adjustable Work-holding Fixture on a Milling Machine

In Fig. 1 an efficient method of using this type of fixture is shown. Two fixtures are in use, and while the cut is being taken across one of the castings the second fixture is being loaded and made ready for the milling operation. Similarly when a cut on the second casting is under way the casting previously milled is removed and a new piece inserted. It is only necessary to loosen one dog for removing the work. C. L. L.

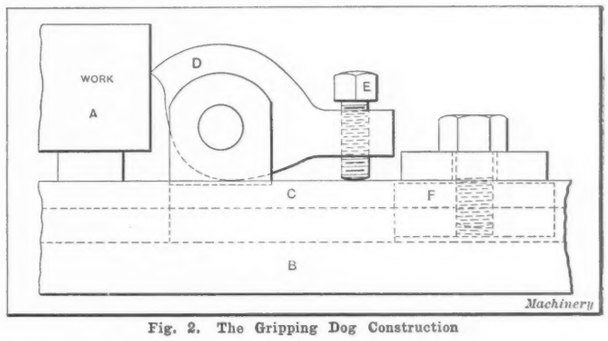

Fig. 2. The Gripping Dog Construction

* * *

"SWAT THE FLY" IN THE DRAFTING-ROOM

The common house fly is becoming recognized as one of the most deadly enemies of the human race. He is a carrier of germs of many diseases and filth of every kind. Experiments conducted in England with marked flies showed that they travel long distances and that sources of contagion may be far removed from the homes of those who become infected through them. "A single fly caught in a refuse can in a suburb of London gave no fewer than 116 colonies of bacteria and ten colonies of fungi, the germs being all collected from the bristles of the insect's legs and body or on its proboscis, as gathered while feeding on the refuse in the can. Flies are active carriers of tuberculosis, ophthalmia, anthrax cholera, infantile diarrhea, etc." Flies are pests in the drafting-room. They not only trouble the draftsmen, but feed on India ink, and have been known to damage tracings by sucking up the inked lines before they become dry. An instance showing how the fly may be responsible for errors in dimensions was recently brought to our attention. A drawing had been made with the dimensions 12", but when sent into the shop the dimension had mysteriously changed to 1.2". Investigation showed that a fly was responsible for the "decimal point." The moral is "swat the fly" in the drafting-room, but, better still, screen the drafting-room to prevent fly-specked drawings and to preserve the health of the draftsmen.

* * *

TWENTY-FOUR-HOUR TIME SYSTEM

A twenty-four-hour time system was recently introduced in France and is said to have given rise to some curious results. One of the troubles the Frenchmen have met with is the striking of the hour. It is apparently not practical to have clocks strike twenty-four strokes or thereabouts in succession because of the difficulty of counting. Numerous peculiar proposals have been made to avoid this trouble, for example, using a double chime, one bell for units and one for tens, the two bells to have different tones. It would seem that it would be feasible to permit the clocks to continue to strike in the same way as hitherto, as this could hardly cause confusion, but that does not seem to suit the French time reformers.

APPLICATIONS OF ELECTROMAGNETIC TRIPPING DEVICES

MECHANISMS WHICH PREVENT DAMAGING MACHINES OR PRODUCING DEFECTIVE WORK

BY GEORGE M. MEYNCKE*

In designing automatic machinery or automatic feeds for standard machines, the designer often faces the problem of providing a suitable device that will make his machine absolutely fool-proof and reliable. This is particularly true in the case of automatic machines where one operator looks after several units. While it is not claimed that purely mechanical means cannot accomplish the same results which

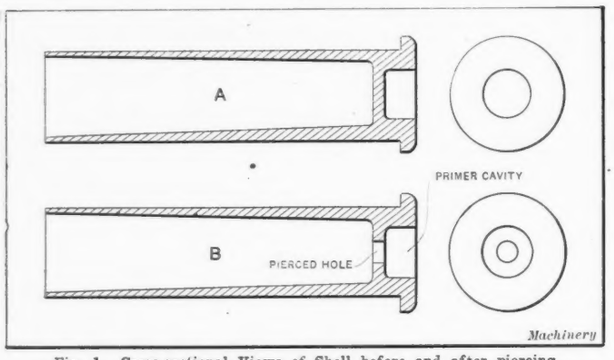

Fig. 1. Cross-sectional Views of Shell before and after piercing Primer Hole

are secured through the use of electromagnetic tripping devices, the mechanisms would necessarily be so complicated—as compared to the electrical devices described in this article—that they would be a source of endless trouble, if not impractical. Another advantage of the electrical devices lies in the fact that they may be used as a check on the accuracy of preceding operations and thus avoid finishing pieces of work that are defective. The application of electricity to automatic machines may be regarded as a complication in itself, but this is far from being the case if these tripping devices are properly applied.

The following examples are typical applications of electromagnetic tripping devices to automatic machines, and by studying these designs the reader will readily appreciate how similar tripping mechanisms could be applied to other classes of machinery; he will also appreciate how these devices put a check on the operation of the machines to which they are applied. In most of these examples, the tripping devices constitute part of attachments for standard machines that were converted into "automatics," thus dispensing with the necessity of an operator for each machine. Electricity performs the vital part of the work; it takes the place of the eyes of the operator and is far more satisfactory than eyes because electricity is more nearly infallible.

Fig. 1 shows a metallic cartridge shell *A* as it is received by the machine which pierces the primer hole, and a shell is illustrated at *B* on which the piercing operation has been performed. After the hole has been pierced, the primer is inserted in the primer cavity by the machine. These operations are performed on a standard Waterbury-Farrel cartridge primer. The shells were formerly placed on dial pins by hand and indexed under the crosshead for piercing and inserting the primer; they were then removed from the dial pins automatically. An improvement was made in the method of operation by applying an automatic feed mechanism to place the shells on the dial pins, but this did not dispense with the necessity of an operator for each machine, as there are three possible conditions that may result in the production of imperfect work: First, the feed mechanism might fail to deliver the shell to the dial pin, or the supply of shells might become exhausted, while primers would continue to feed and thus be wasted. Second, the piercing punch might break and the machine would then continue to place primers in the cavities of shells which had not been pierced, and such shells would obviously be useless. Third, the primer feed might fail to work properly, or the supply of primers might become exhausted.

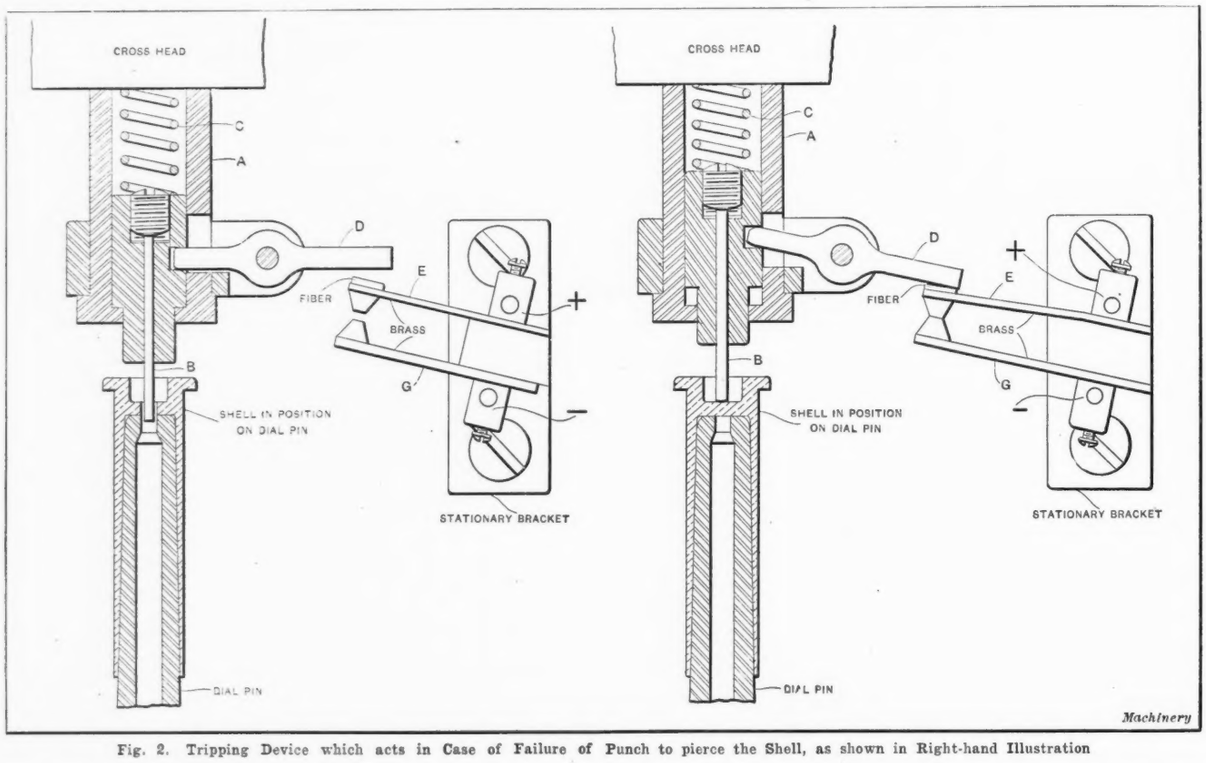

Fig. 2. Tripping Device which acts in Case of Failure of Punch to pierce the Shell, as shown in Right-hand Illustration

The application of a suitable electromagnetic tripping mechanism to this machine now takes care of all of these contingencies. First, we will consider the possibility of the feed mechanism failing to deliver a shell to the dial pin. Referring to Fig. 3 it will be seen that the shells are carried on index points of the dial which carry them under the punch *A*. If a shell is in its place on the dial pin it con-

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tracts the spring *B* when the ram descends, but should the mechanism fail to deliver a shell to the pin, the sleeve *G* passes down over the dial pin and pushes the upper contact *D* of the tripping mechanism down upon the lower contact *E*. This closes the electrical circuit and stops the crosshead on the up-stroke. The contacts are fastened to the frame of the machine and the method by which the tripping mechanism operates will be described in detail later. The way in which the piercing operation is safeguarded by the electromagnetic tripping mechanism is illustrated in Fig. 2. The punch holder *A* is located at the index point immediately after the completion of the piercing operation. If a shell is pierced, the pin *B* descends through the hole in the shell, as shown at the left-hand side of the illustration; but if the piercing operation does not take place, the punch is held in the position indicated in the right-hand illustration, thus contracting the light spring *C* and throwing the lever *D* against the contact *E*. This closes the electrical circuit and causes the machine to be stopped so that shells cannot have primers inserted in them when the primer hole has not been properly pierced. The failure of the machine to feed a primer into the primer cavity of the shell is guarded against by the mechanism illustrated in Fig. 4. The design

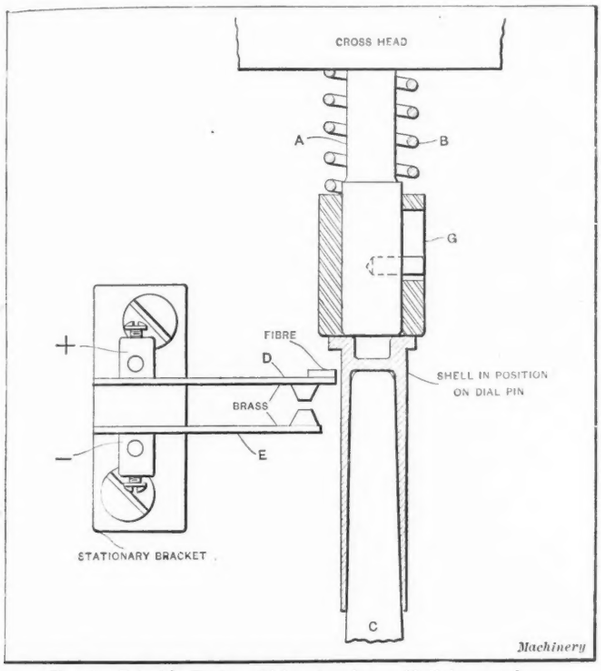


Fig. 3. Tripping Device which acts when a Shell has not been placed on Dial Pin

of this tripping mechanism is practically the same as that used to control the piercing operation and will be readily understood without further description.

Fig. 5 illustrates a press which is used for assembling the brass cups *A* and *B*, the cup *A* being inserted in the cup *B*. These cups are held in hoppers on each side of the machine from which they are taken by notched dials. The cups *A* are dropped into holes in the machine dial which passes over the dial carrying the cups *B*. We will not go into the method by which the machine operates here, it being sufficient merely to state that a plunger descends in such a manner that the cup *A* is forced into place in cup *B*. It will be readily seen that several conditions may occur that will result in loss or damage, *i. e.*, the feed mechanism could fail to deliver either one or both cups to their respective dials, or it could deliver them to the dials in an inverted position. Fig. 5 illustrates how either the absence or inversion of either or both cups is detected by an electromagnetic tripping device which automatically stops the machine until the error has been corrected. The punch *C* is located at an index point preceding the assembling punch and is carried by a bracket which is fastened to the crosshead. In the case of an inverted cup, the punch *C* is held on the bottom of the cup and pulls the rod *G* down through the action of the pinion, which engages with rack teeth cut in the rods *C* and *G*. The descent of the rod *G* causes the contact closer *F* to pull down the upper electrical contact until it closes the circuit and causes the machine to be stopped. The right-hand illustration shows a detail of the punch and die when the feed mechanism has failed to deliver a cup to the dial plate. In this case, the upper electrical contact is pulled

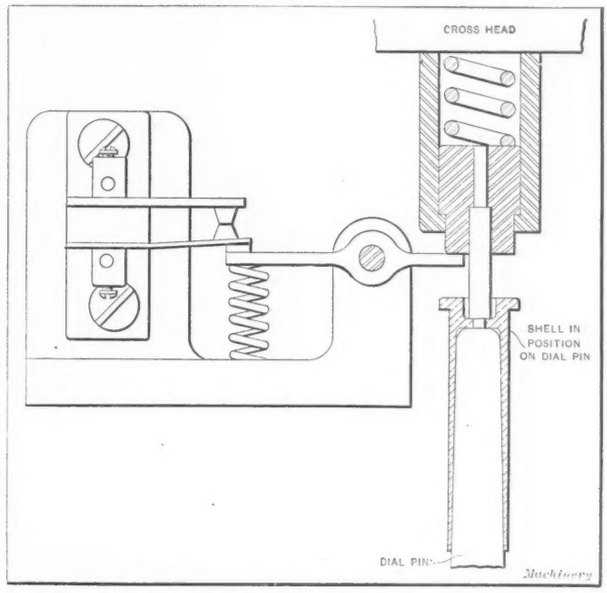


Fig. 4. Trip which prevents passing on a Shell without a Primer

down by the contact closer *H* and causes the machine to be stopped as previously described.

Fig. 6 shows the electromagnetic tripping device used on the machines referred to in the preceding paragraphs. In this illustration, the tripping device is shown in place on a power press equipped with a Horton clutch. The design and contraction of the tripping mechanism will be more readily understood by referring to Fig. 7, which shows an end and

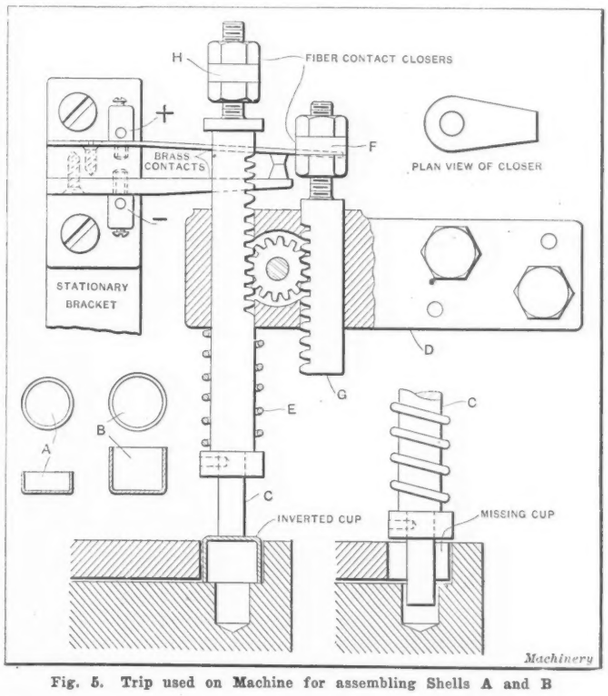


Fig. 5. Trip used on Machine for assembling Shells A and B

cross-sectional view. This tripping mechanism is self-contained and can be applied to any style of press or type of machine. It will be seen that the bracket *A* carries the magnet *B*, pole-piece *C*, and levers *D* and *E*. The brass pole *G* is wound with No. 14 double-covered wire and the lead wires are carried off through the back of the spool. The

brass pins H help to support the pole-piece C and provide adjustment for different widths of air gap which should be as small as possible. In order to start the press, the lever E is pulled down. This pulls out the flywheel clutch (see Fig. 6) and allows the spring J to pull the lever D over the hardened knife-edge, thus setting the pole-piece C at the proper working distance from the magnet. The inside dimensions of the device are given in Fig. 7, and when the magnet is energized by two dry cells, it gives an initial pull or jerk of from twelve to fifteen pounds. As the dry cells are used on open-circuit—except for the fractional part of a second during which the contacts meet—they have a long life.

The initial pull provided by an electromagnet of this kind varies with the material used for the magnet and pole-piece. Where cast iron is used, the pull of the magnet can be calculated by the formula:

$$NI = 3000\ Z\ \sqrt{P \div D}$$

in which N = number of coils of wire on spool (ampere-turns);
I = current in amperes;
P = pull in pounds;
Z = air gap in inches;
D = diameter of plunger in inches.

The electromagnet shown in Fig. 7 was designed to give a pull of fifteen pounds, and it will be seen that $Z = 5/16$ inch and $D = 1.125$ inch.

Then $NI = 3000 \times 5/16\ \sqrt{15 \div 1.125} = 3423.19$ ampere-turns.

Assuming that there are 375 turns of wire on a spool, the amount of current required will be found to be $\frac{3423.19}{375} = 9.14$ or, say, ten amperes. Two good dry cells connected in series will average fifteen amperes during their useful life and give a considerably higher current when new. As ten amperes is sufficient to enable the electromagnet to do the work required of it, it will be seen that an ample factor of safety is provided. When designing devices of this kind, moving wires and moving contacts should be avoided and the mechanism should be made as simple as possible. The dry cells should be used on open circuit, the contacts carefully insulated from the machine and covers provided for contacts and terminals.

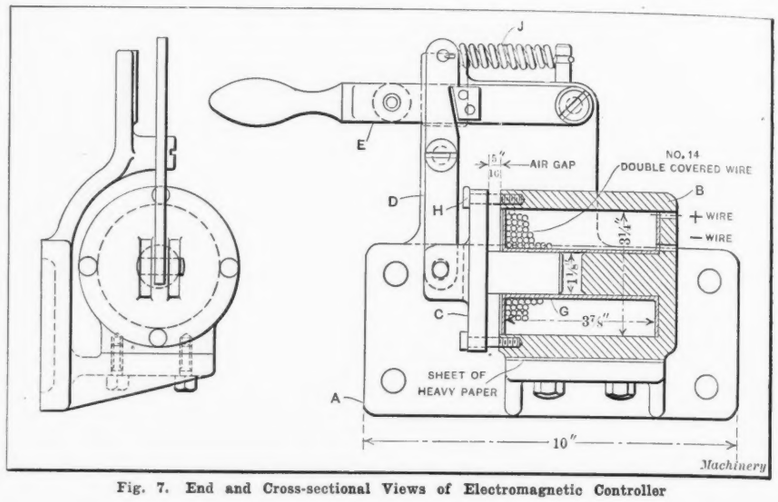


Fig. 7. End and Cross-sectional Views of Electromagnetic Controller

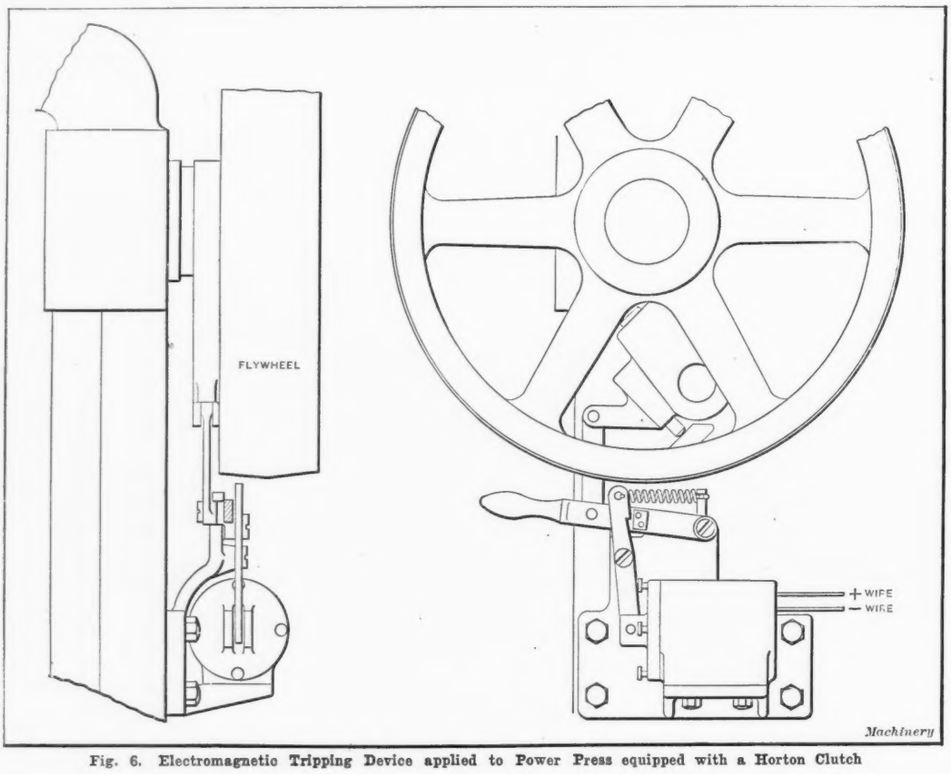


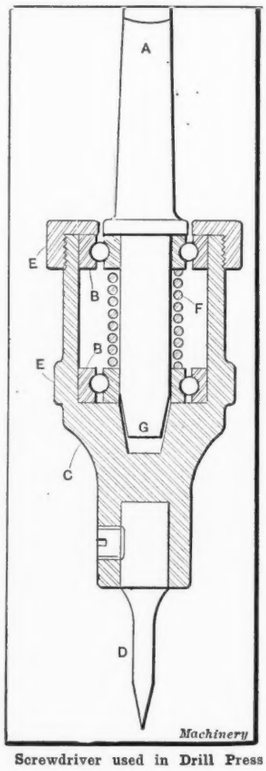
Fig. 6. Electromagnetic Tripping Device applied to Power Press equipped with a Horton Clutch

FRICTION DRIVEN POWER SCREWDRIVER

BY W. ALTON

The following is a form of screwdriver that will be found useful where there are a large number of screws to be put into parts that are small enough to handle under a drill press. It consists of an arbor with a taper shank A fitted to the drill press spindle in which it is desired to use the tool. The opposite end G of the arbor is tapered to fit a corresponding recess in the body C of the tool. The arbor runs in ball bearings B, the outer race of the left-hand bearing being a sliding fit in the body C and the inner race of the right-hand bearing being a sliding fit on the mandrel. The tapered clutch end G of the mandrel is kept out of engagement when the tool is not in use by the spring F.

The body of the tool can be stopped to engage the screwdriver D with the slot of the screw by grasping it around the knurled portions E, but in practice this is hardly necessary as the screwdriver will usually engage the screw if fed down on it. A further advantage is that the clutch will release when the screw is driven in. This tool is easily made and will be found a time saver in doing the class of work for which it was designed.



Screwdriver used in Drill Press

MACHINE FORGING—6

DIES AND METHODS EMPLOYED IN THE FORMING, WELDING AND UPSETTING OF MACHINE AND ENGINE PARTS

BY DOUGLAS T. HAMILTON*

The forming and welding operations illustrated and described in the following represent some of the interesting applications of upsetting and forging methods to the production of locomotive and car parts. Three methods of welding parts are given, which practically covers the entire range

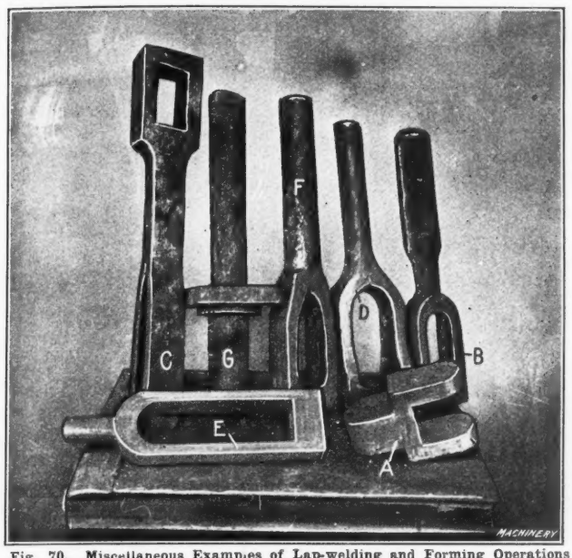


Fig. 70. Miscellaneous Examples of Lap-welding and Forming Operations accomplished on a 6-inch Ajax Universal Forging Machine

handled. Mention is also made of the important part filled by bulldozers and steam hammers in the production of many parts, and of their close connection as manufacturing auxiliaries to the forging machine.

Miscellaneous Lap-welding and Forming Operations

The miscellaneous welded and formed parts shown in Fig. 70 were secured in the Chicago shops of the C. & N. W. Railway through the assistance of A. L. Guilford, manager of the Chicago office of the Ajax Mfg. Co. The forging dies and tools shown in the following illustrations constitute a few of the many interesting examples to be found in the shop mentioned, and represent the results of the endeavors of T. E. Williams,

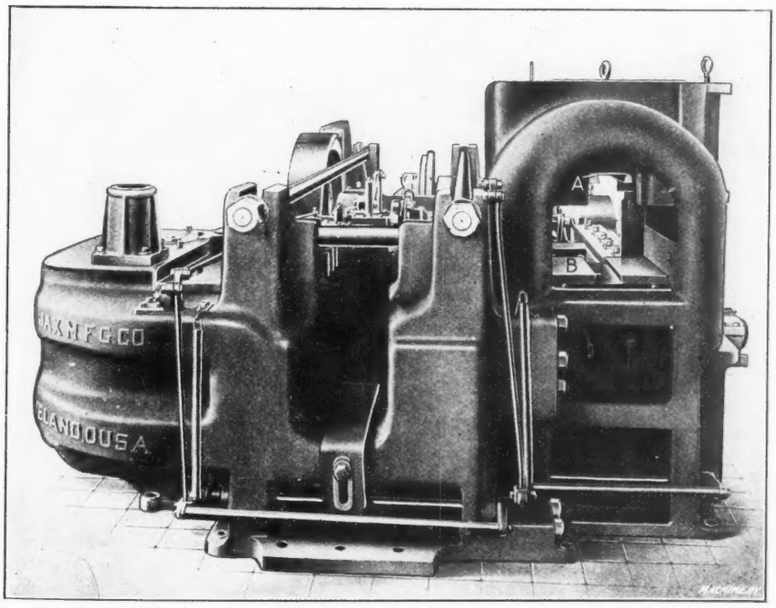


Fig. 71. Six-inch Ajax Universal Forging Machine used in the C. & N. W. Railway Shops for making the Forged Parts shown in Fig. 70

master smith, to decrease the cost of forged engine and car parts. All of the examples shown in Fig. 70 were produced on the 6-inch Ajax universal forging machine shown in Fig. 71.

*Associate Editor of MACHINERY.

Universal Type of Upsetting and Forging Machine

The universal type of upsetting and forging machine shown in Fig. 71 has a much greater range of possibilities for producing machine-made forgings than the regular upsetting and forging machines previously described. This machine has the features common to the regular forging machine in combination with those of a powerful vertical press operated independently of the other part of the machine. The universal forging machine is designed especially for forming such forgings as require squeezing, punching or trimming operations either before or after upsetting. This often makes it possible to prepare and complete large upsets and difficult shaped forgings in one handling, and thus utilize the initial heat.

In construction, it consists mainly of a double-throw crankshaft from which are operated two header slides—one for the standard upsetting mechanism and the other for the vertical press. The upper die-holder *A* of the vertical press is operated by two heavy steel side links, the lower ends of which connect with eccentrics on an oscillating shaft. This die-holder is pro-

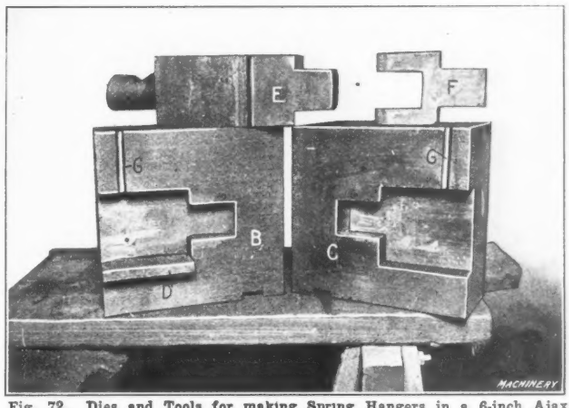


Fig. 72. Dies and Tools for making Spring Hangers in a 6-inch Ajax Universal Forging Machine

vided with means of adjustment so that the squeezing dies can be brought together or separated as requirements demand. The lower member of the dies used in this auxiliary part of the machine is held on the stationary die-holder *B*.

Dies and Tools for making Spring Hangers

An interesting example of the utilization of scrap metal for making engine parts is the spring hanger *A*, Fig. 70. This part is made from old arch bars 1 by 4 by 5 inches, with the dies and tools shown in Fig. 72. Six blocks cut off from the arch bars are piled together and riveted as shown at *A* in Fig. 73, the old holes in the arch bars serving as a means for riveting them together. This is done to hold the separate blocks in place while a welding heat is being taken. After the parts have reached the proper temperature they are taken to the universal forging machine shown in Fig. 71, and placed between squeezing dies held in the vertical press. The machine is then operated, welding the pieces together and converting them into a solid block as shown at *B* in Fig. 73.

After the separate pieces have been welded and shaped, the solid block is again taken to the furnace and heated to a welding temperature. Then it is removed and placed between the opposing faces of the gripping dies *B* and *C* shown in Fig. 72, these being held in the forging machine shown in Fig. 71. The stationary gripping die *B* is provided with the shelf *D* on which the heated block is placed, this serving to hold it while the dies are coming together. As soon as the dies close on the work, plunger *E* advances and displaces the stock in

such a manner as to form the tail on the end of the forging *F* by simply forcing the center portion of the block back into the rear impressions in the gripping dies. This is accomplished in one heat, and when the piece is removed from the dies it is finished complete. Vent holes *G* are provided in the opposing faces of the dies to allow the excess metal to escape.

Another example of a spring hanger forging is shown at *B* in Fig. 70, the dies and tools used being shown in Fig. 74. The first operation in the production of this spring hanger is drawing the 2-inch wrought-iron bar *A* down to the shape shown at *B* in Fig. 75 in a Bradley steam hammer. This piece, after being drawn down is heated and placed in a bulldozer, where it is bent into a U-shape as shown at *C*, the heaviest part of the piece being located at the bent end. The one-inch hole is punched through the bent end at the same time that the work is being formed. The body or shank of the hanger is made from a 1 by 4-inch piece of round edge iron *D* which is swaged down on a 4-inch forging machine to 1¾ inch round for a length of about 7 inches on one end, as

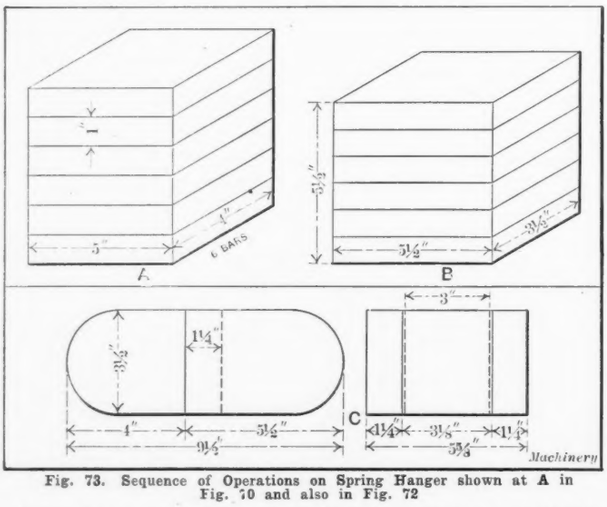


Fig. 73. Sequence of Operations on Spring Hanger shown at A in Fig. 70 and also in Fig. 72

shown at *E*. The bar is then heated, placed in the forging machine and upset to 2 inches in diameter in order to completely form the reinforced portion on the flat part, and at the same time reduce the end to one-inch in diameter by 2¼ inches long. The reduction on the end of the bar is accomplished with the plunger held in the ram of the machine.

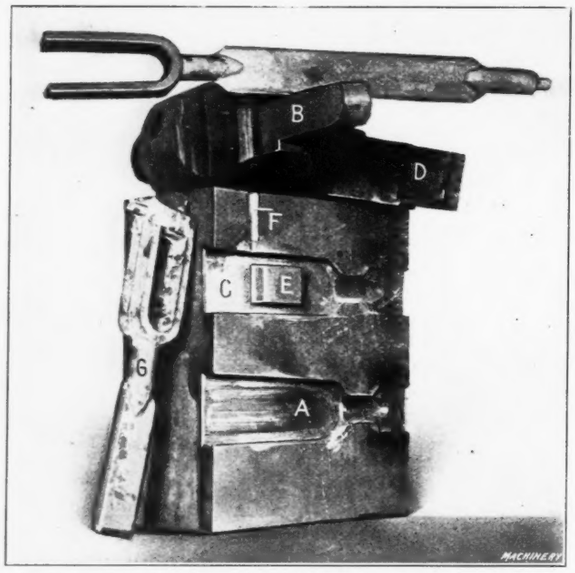


Fig. 74. Dies and Tools used in making Spring Hanger shown at B in Fig. 70—also illustrating Pin Welding Operation

The loop *C* is now placed on the reduced end of the rod as shown at *G* and is riveted cold, just enough to hold the two pieces together while a heat is being taken. The work is then raised to a good welding heat, and is quickly placed in the lower groove *A* (see Fig. 74) of the dies held in the 6-inch forging machine shown in Fig. 71, where the work is formed by plunger *B*. The reason for doing this work in a 6-inch forging machine is that the plunger travel necessary is 14 inches, and this would be impossible on a smaller machine than that having a 6-inch capacity. This 14-inch travel, of course, is after the dies have been closed on the work. After the two pieces are welded together as shown at *H* (Fig. 75) a block *a* of 2-inch square iron 3 inches long is placed in the

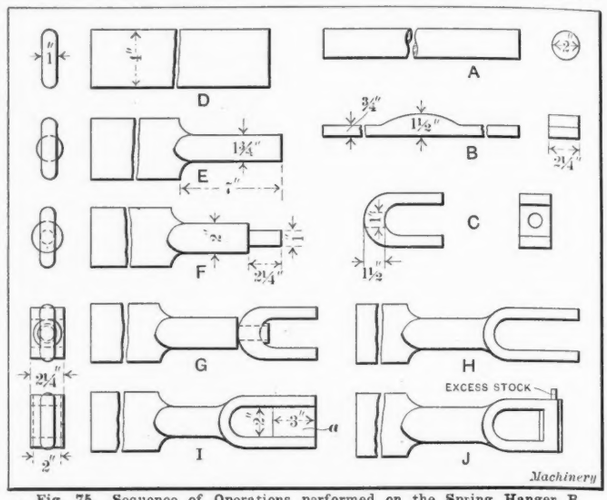


Fig. 75. Sequence of Operations performed on the Spring Hanger B shown in Figs. 70 and 74

U-end of the forging as shown at *I* and a welding heat taken. The work is then placed in the upper groove *C*, Fig. 74, of the dies and as the plunger *D* advances it upsets the forging to the proper shape around the embossed center portions *E*, the excess metal flowing up through the vent holes *F* provided in the gripping dies. The finished forging is shown at *J* in Fig. 75.

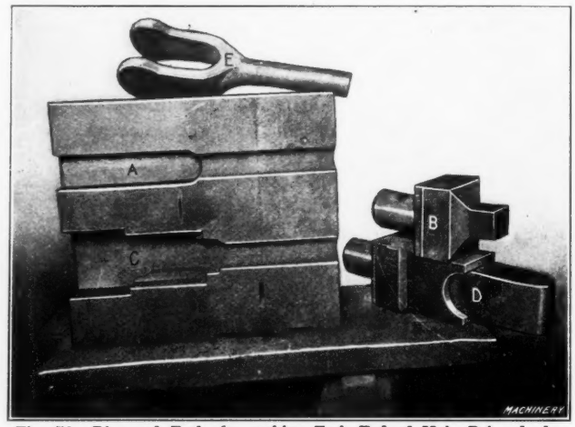


Fig. 76. Dies and Tools for making Fork End of Main Driver-brake Pull Rod shown at D in Fig. 70 in a Forging Machine

Still another type of spring hanger which is completed in the forging machine is shown at *C* in Fig. 70. This is made from a rectangular bar of wrought iron which is first lapped over and then welded, after which the eye end is formed to shape on the forging machine. The square hole is roughformed by the vertical press of the universal forging machine shown in Fig. 71, and is then finished in the upper impression in the dies held in the horizontal part of the forging machine. No material is removed to form the square hole, the metal simply being expanded, increasing the width of the bar.

Dies and Tools for making Fork End of Main Driver-brake Pull Rod

The fork end of the main driver-brake pull rod shown at *D* in Fig. 70 is made from a 2¼-inch bar of round wrought iron which is first squeezed down flat on one end until the flattened end is 3 inches wide by 14 inches long. This operation is handled in the vertical head of the machine shown in Fig. 71. A piece of ½ by 3 by 14-inch wrought iron is laid on the flattened portion of the bar (both pieces, of course, being heated) so that they can be stuck together by the dies held in the vertical head of the universal forging machine, thus holding them while the welding heat is being taken. The next step in the production of this fork is to increase the diameter of the rod from 2½ to 3 inches square. This opera-

tion is accomplished in the upper grooves *A* of the dies shown in Fig. 76, using the plunger *B* for upsetting. The 3-inch squared end is now split for about 9 inches of its length with suitable tools held in the vertical head of the machine, and at the same time is opened up slightly. The piece is then taken

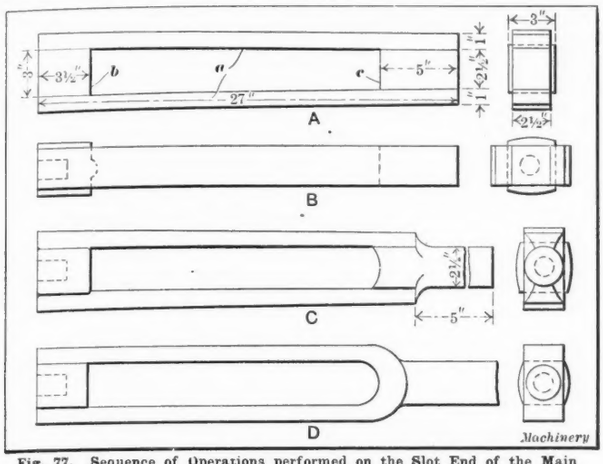


Fig. 77. Sequence of Operations performed on the Slot End of the Main Driver-brake Pull Rod shown at E in Fig. 70

to the furnace and heated, after which it is placed in the lower grooves *C* of the dies, and with one blow of plunger *D* is brought to the final shape as shown at *E*.

Dies and Tools for making Slot End of Main Driver-brake Pull Rod

The slot end of the main driver-brake pull rod shown at *E* in Fig. 70 is made as shown in Fig. 77 from two pieces *a* of

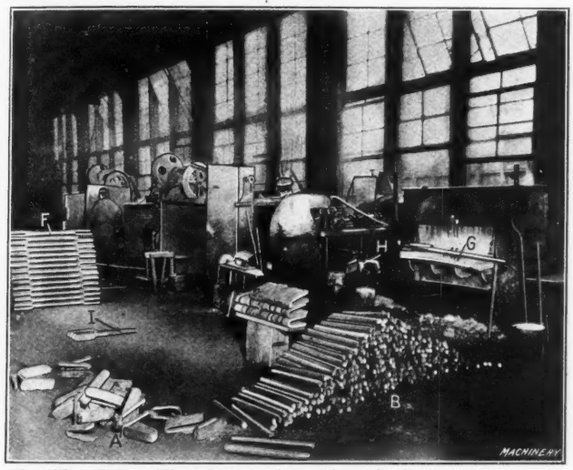


Fig. 78. Butt-welding Bottom Connecting-rods in an Ajax Forging Machine in the Collinwood Shops of the L. S. & M. S. Railway

1 by 2½-inch flat bar iron 27 inches long, one piece *b* of 3-inch square iron 3½ inches long, and one piece *c* of 2½-inch square iron 5 inches long. The two pieces *a* are clamped by a pair of tongs on the end where the block *c* is located and a welding heat is taken on the other end. The work is then removed from the furnace by the tongs and quickly placed in the top groove of the dies. The machine is operated and as the plunger, which has a punch on its front end, advances, it punches a hole in the work and displaces the stock, forming a boss on each side as indicated at *B*. The position of the tongs on the work is then reversed and the other end of the forging is heated, after which it is swaged to 2½ inches in diameter for a distance of 5 inches on this end to the shape shown at *C*. This operation is handled by the gripping dies which are provided with circular grooves located between the upper and lower impressions. The forging is again heated and placed in the lower impressions of the dies, the round part entering the plunger. The machine is then operated, forming the forging to the shape shown at *D*.

Butt-welding Bottom Connecting-rods

In the fifth installment of this article, which appeared in the September number of MACHINERY, it was mentioned that butt-welding is seldom accomplished on forging machines, owing to the difficulty generally experienced in successfully making this type of weld. The bottom connecting-rods shown in Fig. 78 and also at *F* in Fig. 79, are produced satisfactorily by butt-welding in the Collinwood Shops of the L. S. & M. S. Railway, so that a description of the method used in handling will no doubt be appreciated. The stock for the forked ends *A*, Fig. 79, is sheared off from a bar of 2½ by ¾-inch wrought iron and bent to a U-shape in the bulldozer. The center portion of this connecting-rod is made from 1¾-inch round wrought-iron bars which are also sheared to the required length before coming to the forging machine.

The U-shaped pieces *A* and bars *B* are now placed in the furnace *G*, Fig. 78, where they are heated to a welding temperature. The operator then removes a rod and also a U-shaped piece and butts them together as indicated in the illustration; he then places the pieces which are stuck together in the impressions in the gripping dies *C* and *D*, Fig. 79, and operates

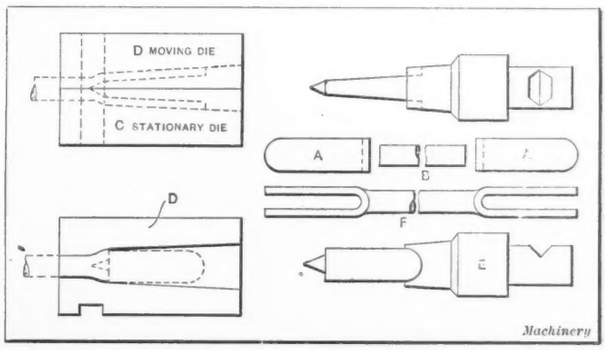


Fig. 79. Illustrations showing Sequence of Operations in the Butt-welding of Bottom Connecting-rods, shown in Fig. 78

the machine. Now as plunger *E*, which has a pointed end, advances it forces itself through the fork into the round stock, thus intermingling the grain of the material and insuring a solid weld. To prevent scale from forming on the pieces to be welded, a small jet of compressed air is made to play on them just before and while the machine is operating.

After welding, the work is removed from the gripping dies and placed between suitably shaped forming dies held in the side shear *H*, Fig. 78. The machine is then operated, forming the U-shaped end to the proper shape, after which the piece is thrown down in the sand to cool off (see *I*, Fig. 78). After all the rods have been completed in this manner, the other or straight end is placed in the furnace and the procedure followed that was previously described. The completed bottom connecting-rods are shown at *F* in Figs. 78 and 79, respectively. To prove that this type of weld was satisfactory, numerous tests were made to break it at the welded joints.

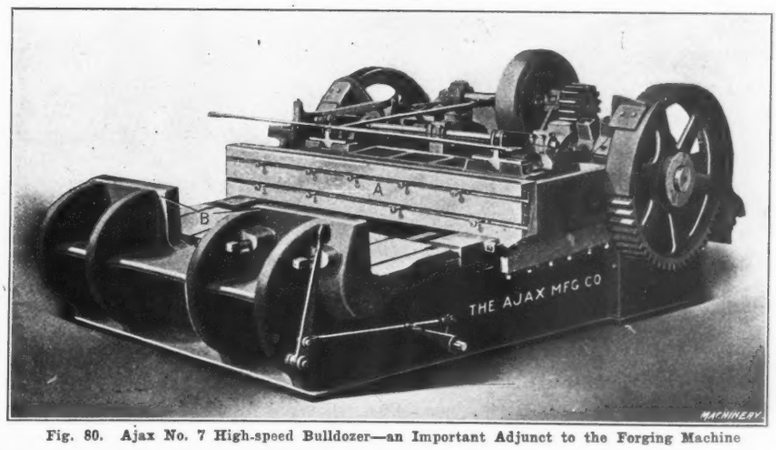


Fig. 80. Ajax No. 7 High-speed Bulldozer—an Important Adjunct to the Forging Machine

This was not accomplished until the testing machine registered a pull of 74,000 pounds, which is equivalent to a tensile stress of approximately 30,000 pounds per square inch. As the tensile strength of wrought iron seldom exceeds 48,000 pounds

per square inch, it will readily be seen that this type of weld would be satisfactory for the general run of forged work.

Bulldozer as an Auxiliary to the Upsetting and Forging Machine

Considering that so many parts completed on the forging machine can be handled successfully only when partially formed by the bulldozer it may not be out of place to include a short description of this type of machine. Fig. 80 shows the type of bending and punching machine known as the bulldozer, which is used so extensively as an auxiliary to the forging machine in the manufacture of many forgings.

The construction of this type of machine is simple, consisting primarily of a moving crosshead *A* which carries one member of the forming dies, the other member of the forming dies being held against the toes *B* of the machine. The operations are accomplished by the forward travel of the crosshead, the work as a general rule being completed in one travel of the head. Of course while the machine is fairly simple in construction and operation, many types of interesting forming tools are used. However, it will be impossible to go into this subject fully in this article, as it is necessary to confine our attention more particularly to the forging machine rather than to its auxiliaries.

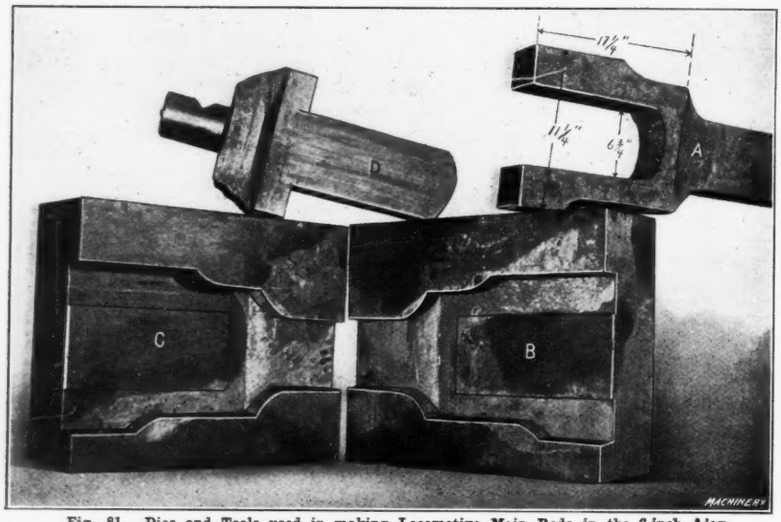


Fig. 81. Dies and Tools used in making Locomotive Main Rods in the 6-inch Ajax Universal Forging Machine

The forming tools for the bulldozer can generally be made cheaper and more conveniently from cast iron, especially when they are provided with hardened steel plates where any friction takes place—that is, those parts of the tool which actually do the forming or shaping should, as a general rule, be reinforced with hardened steel plates. This enables the tools to be renewed very cheaply, as the plates when worn out can be replaced by new blocks of steel. The roller type of tool which is carried and operated by the crosshead is the best for saving material and power when it is possible to use this type. However, the type of tool to use depends largely on the shape to be formed and other requirements. In all cases where hot punching or cutting is done, high-speed self-hardening steel should be used for the working members of the tool.

Tools for making Engine Main and Side Rods in the Forging Machine

The locomotive main rod shown at *A* in Fig. 81 is the largest piece of work ever handled in a forging machine in the Chicago shops of the C. & N. W. Railway. The main rod is first roughed out under a steam hammer and the end split before it is brought to the forging machine shown in Fig. 71. The roughing out of the slot and the finish-forming in the forging machine are done in one heat. In the forging machine the work is gripped by the dies *B* and *C* and is upset and formed to shape by the plunger *D*.

Another good example of heavy forging accomplished in the Ajax 6-inch universal forging machine is the locomotive side rod shown at *A* in Fig. 82. This side rod is made from square stock drawn down to the required size under the steam hammer, and is upset and formed on each end in the forging machine shown in Fig. 71. The gripping dies, only one of which is shown at *B* in Fig. 82, are used for forming the end *C* of the rod. It requires two operations to complete this end. The first operation is performed in the lower groove *D* of the dies and consists in rough-forming the slot with the plunger *E*. The work is then placed in the upper groove *F* and completely formed to shape by means of plunger *G*.

The other end *H* of the side rod is upset and formed to shape by another set of dies—only one of which is shown at *I*. The rod, which is heated to a welding temperature, is placed in the impressions in the gripping dies and is upset and formed to the required shape by means of the plunger *J*. These two examples of machine forging illustrate very well the adaptability of the forging machine to locomotive manufacture.

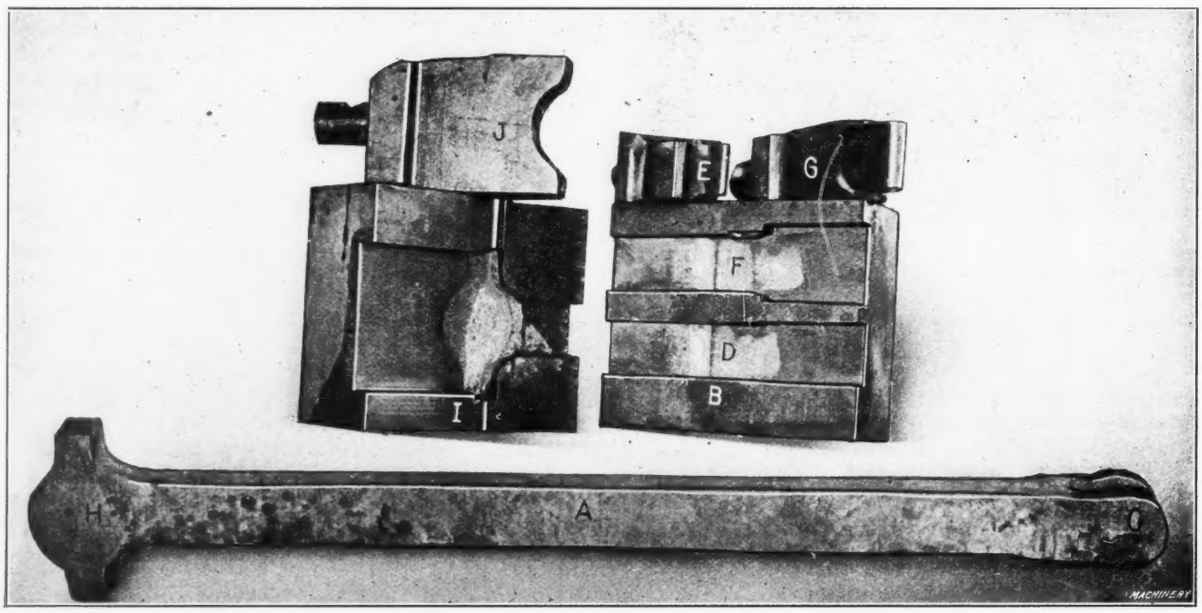


Fig. 82. Dies and Tools used in the Ajax 6-inch Universal Forging Machine for making Locomotive Side Rods in the C. & N. W. Railway Shops

HANDLING A LARGE TURRET LATHE JOB

At the shops of the United States Light & Heating Co., Niagara Falls, N. Y., some very interesting turret lathe work is handled on Warner & Swasey machines. One of these jobs in particular is unusual because of the extreme size of the work, and the number of tools in the set-up. The tool set-up is shown in Fig. 1, and the piece in question is illustrated in Fig. 2 which shows the work in section and the chuck in side elevation. This is an aluminum casting, being a mounting frame for an electric starter for automobiles. The casting is 18 inches in diameter over-all, and is machined on

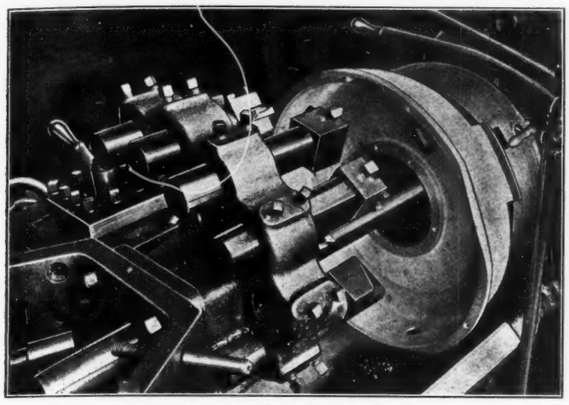


Fig. 1. A Turret Lathe Job and the Special Tools employed

ten surfaces. These surfaces are finished with eight tools, all of which cut simultaneously.

The entire machining is accomplished without indexing the turret so that the operation is very simple after the tools have once been set up. Referring to Fig. 1, it may be seen that five of the tools are supported from the special turret bracket, which is, in turn, bolted to one of the turret faces. The sixth tool is mounted on a boring-bar that is supported from the turret, and the seventh and eighth tools are held in the front carriage of the turret lathe. On account of the size and thinness of the walls of the casting, it is somewhat difficult to support it, and the gripping is done from the inside of the central hole, as shown in Fig. 2.

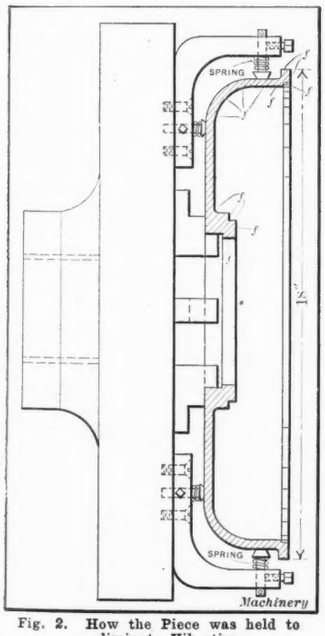


Fig. 2. How the Piece was held to eliminate Vibration

The machining of a casting or shell with thin walls is always productive of chatter. As chatter is one of the chief causes of the dulling of tools, it is important to reduce it to a minimum. This is done by providing spring pins that extend from four brackets supported from the chuck body and spaced equidistantly around the casting. From each of the brackets two pins extend, one against the back and the other against the side of the casting. After the piece has been chucked, allowing the pins to bear against the work, set-screws are tightened, thus backing up the work securely and supporting it while being turned. These pins serve to obviate the vibration which would otherwise occur. Two of the sets of spring pins and brackets are illustrated in Fig. 2, but do not appear in Fig. 1. For a cutting lubricant "Magic" compound is used with excellent results.

The work was formerly performed upon a large engine lathe, and the output was but ten pieces per day when done in this manner. On the Warner & Swasey 3-A machine, however, the output is seventy-five pieces per day, and the production is more accurate. C. L. L.

* * *

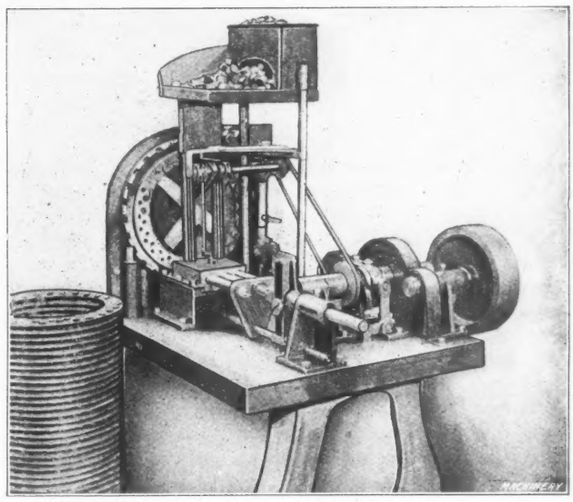
INSERTING CORKS IN CLUTCHES

BY H. F. HINES*

The illustration shows a semi-automatic machine for inserting corks in the steel disks of multiple automobile clutches. These disks have fifty-six holes 7/16 inch in diameter, the holes being staggered as shown in the partially filled disk mounted in the machine. The corks used for these clutches are 11/16 inch in diameter before they are compressed to be forced into the disk.

The operation of the machine may be briefly described as follows: The disk is placed on the revolving head of the machine and located by two small plungers, after which it is securely clamped in position. The locating plungers enter holes on opposite sides of the disk and when the corks are inserted in these holes they push the plungers back. The head which carries the disk is automatically indexed by means of a lever and pawl. This index mechanism is actuated by a cam on the crankshaft, the head being indexed after each stroke of the plungers which press the corks into the disk.

The corks are placed in a hopper at the top of the machine which delivers them to two feeding chutes, small wire brushes



Special Machine for inserting Corks in Automobile Disk Clutches

being provided to force the corks through the chutes into the slides in which the plungers operate. As the corks drop in front of these plungers on their forward stroke, they are driven through tapered bushings which reduce their diameter from 11/16 to 7/16 inch—the size of the holes in the disk. As the fit of the corks in these bushings becomes tight, it causes the slide to be pushed up against the disk, and as the plungers continue their forward stroke, they force the corks into place. As soon as the plungers start on their return stroke, a small catch pulls the slide off the ends of the corks which project from the disk and thus allows the disk to be indexed by the time the plungers have reached the end of their return stroke and are ready for the next operation.

It will be seen from the illustration that the crosshead which carries the plungers is operated by a crank on the end of the main driving shaft, the action of the machine being controlled by a foot treadle which operates a clutch on the driving shaft. The machine will continue to run as long as the treadle is held down, but stops at the end of the first return stroke which is made after the treadle has been released. The machine runs at about forty strokes per minute, and as two corks are inserted at a time a disk is completely filled in about forty seconds. The efficiency of the machine is indicated by the fact that it has made a record of filling four hundred disks in 9 hours 20 minutes, requiring the insertion of 22,400 corks.

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THE DUTIES OF A FOREMAN

Just exactly what the duties of a foreman are depends, of course, largely upon the conditions in various shops. In some, he may be selected largely because of his mechanical knowledge and of his ability to direct the work from a mechanical point of view. In others, the work may be of such a nature that his mechanical qualifications are of minor importance, but his general executive ability is of greater value. It is certain, however, that the foreman should not be selected because of his ability as a clerk; and yet in many shops a large proportion of his time is occupied by work that is purely clerical: making out reports, keeping records, filling in and signing stock orders, etc. In fact, he does work which could and should be done by men who do not possess his qualifications for mechanical training or executive ability, leaving him free to devote himself to the greater task of managing his department.

It is in line with good management, whether it be "scientific" or otherwise, to relieve superintendents and foremen of their clerical work and permit them to devote their time and energy to running their departments and to obtaining the highest efficiency. It is poor policy to save the pay of an ordinary clerk at the expense of having the whole department, where scores of men are employed, run in a haphazard way. There are too many cases where this condition exists, and there are even so-called "well managed" shops that require their foremen to spend nearly half of their time in doing work that a clerk receiving one-third the pay could do with equal efficiency.

* * *

PANAMA-PACIFIC INTERNATIONAL EXPOSITION

The Panama-Pacific Exposition to be held in San Francisco in 1915 promises to be an event of unusual international importance, notwithstanding the fact that Great Britain and Germany have refused to participate. It will mark the beginning of a new period in the world's commerce. The diversion of ocean trade through the Panama Canal will undoubtedly have a profound effect on the commerce of the world in general and that of the United States in particular.

World's fairs have been promoted freely during the past twenty years and such enterprises have undoubtedly been overdone in Europe, but it should be remembered that none of those held during the past five years has had the international significance of the event to occur in 1915. This exposition will bring the East and the West closer together, open new avenues of trade and broaden those already open. The liberal policy of the exposition management with regard to small exhibitors in permitting a number to club together and exhibit in one space with all the rights and privileges of independent exhibitors should encourage many to show their products, who under the ordinary conditions of exhibition at world's fairs would not or could not do so.

The exhibition will be on a vast scale. The machinery building alone will have nearly eight acres of floor space. All parts of the building will be served by adequate crane facilities, and electric current both alternating and direct, and gas and water will be available in all parts of the building. Compressed air and steam will be provided adjacent to the gas and fuel section, and general illumination will be provided by the exposition company. Eastern manufacturers interested in developing trade in the Pacific coast states will largely embrace the opportunity to make their products known and at the same time become personally acquainted with the conditions of Western and Oriental business.

* * *

A GERMAN VIEW OF SCIENTIFIC MANAGEMENT

It has been said that one must go to Germany to see American systems of factory management carried out to their full possibilities and logical conclusion. It has also been said that when the Germans begin to adopt the scientific management system developed in America they will organize their factories along these lines much more rapidly and efficiently. The reason given for this is that the German people, on account of their temperament and training—their military services and consequent habits of obedience to superiors—would fit into a system of scientific management much more readily than would Americans. While no doubt there is considerable truth in these assumptions, prominent Germans themselves do not believe that the "millennium" of scientific management will arrive very quickly. Prof. Schlesinger, who presented a paper on this subject at the joint meeting of the Society of German Engineers and the American Society of Mechanical Engineers at Leipzig the past summer, dwelt on the point that no matter how well adapted a people may be to work under this system, the great difficulty of securing properly trained managers for installing the new system and operating factories under it will always exist. He pointed out that a system of management properly carried out along the lines laid down by Taylor requires managers and engineers of unusual ability. Not only must they be well trained, both in the theory and practice of their line of business, but they must, in addition, be exceptional students of human nature and keen observers of human traits. This is a point of great importance and one which is often overlooked. People speak of scientific management as though it were something that could be bought and sold in the market, that can be accepted or left alone, as they please, but it is not so. Scientific management can be logically and properly installed and carried on only by men of exceptional qualifications; and it is not a system which anyone can adopt and install at will. This is probably the reason for the many alleged failures of this type of management reported; and also for the misunderstanding and misconception of the system itself.

Scientific management is by no means an entirely new development, although it was worked out in more minute details and given more prominence, as well as a name, by Mr. Taylor and others who have taken up his work; but the principles of scientific management have been applied in many of the well managed factories in this and other countries for years, and the extent to which these attempts in the past were successful as systems of management depended on the personal factor—on the manager. And so it will continue in the future. Men with the peculiar capacity for leading other men along definite, well-thought-out and systematic lines will succeed with scientific management, while those who have not this ability will fail, and will have to be satisfied with getting along in the conventional way.

PRICE-CUTTING VS. PRICE-MAINTENANCE

The recent decision of the U. S. Supreme Court, that selling a patented article for less than the specified retail price does not constitute an infringement of the patent, removed a bulwark behind which much of the fixed-price business of the country was established. The decision is one viewed with satisfaction by those who realized that the use of the patent privilege to fix prices was a serious, if not a dangerous, abuse of the law. But the price-cutting likely to result in retail trades from the removal of the means for holding retailers to fixed prices may work much injury. Louis D. Brandeis, the well-known lawyer, active in progressive legislation, has published a protest against price-cutting and a plea for the maintenance of the fixed-price principle when not coupled with monopoly. An extract from his statement which follows is of general interest:

There is no improper restraint of trade when an independent manufacturer in a competitive business settles the price at which the article he makes shall be sold to the consumer. There is dangerous restraint of trade when prices are fixed on a common article of trade by a monopoly or combination of manufacturers.

The independent manufacturer may not arbitrarily establish the price at which his article is to sold to the consumer. If he would succeed he must adjust it to active and potential competition and various other influences that are beyond his control. There is no danger of profits being too large as long as the field or competition is kept open; as long as the incentive to effort is preserved; and the opportunity of individual development is kept untrammeled. And in any branch of trade in which such competitive conditions exist we may safely allow a manufacturer to maintain the price at which his article may be sold to the consumer. Competition is encouraged, not suppressed, by permitting each of a dozen manufacturers of safety razors or breakfast foods to maintain the price at which his article is to be sold to the consumer.

By permitting price-maintenance each maker is enabled to pursue his business under conditions deemed by him most favorable for the widest distribution of his product at a fair price. He may open up a new sphere of merchandising which would have been impossible without price protection. The whole world can be drawn into the field. Every dealer, every small stationer, every small druggist, every small hardware man can be made a purveyor of the article, and it becomes available to the public in the shortest time and the easiest manner.

Price-cutting of the one-priced trademark article is frequently used as a puller-in to tempt customers who may buy other goods of unfamiliar value at high prices. It tends to eliminate the small dealer who is a necessary and convenient factor for the widest distribution; and ultimately, by discrediting the sale of the article at a fair price, it ruins the market for it.

Price-cutting is one of the most efficient means of establishing monopoly in retail trade. The dealer who offers to sell a well-advertised fixed-price article at or below the wholesale price does so for an ulterior purpose. The sale of the advertised article is limited and the constant effort is to induce customers to buy other and "just-as-good" articles yielding a larger profit. Competition having been destroyed by price-cutting methods, the field is open for high prices and the abuses that invariably follow the establishment of a private monopoly.

* * *

Machine contractors who bid on work for the government find that the law requiring that all government work done under contract must be carried through by men working on the eight-hour day basis necessitates their placing much higher bids upon the work. Two years ago the successful bidder on a lot of 5000 3-inch cast-iron shells was awarded the contract on a bid of eighty cents each, his men being employed on the ten-hour day basis. Recently when bids were received for a similar lot of 5000 of these shells to be made to the same specifications, the lowest bid was one dollar and forty cents each, and it is claimed that the increased figure of the last bid was largely due to the fact that the work must be done on the eight-hour day basis.

POINTS ON BROACH-MAKING

BY FRANKLIN D. JONES*

Broaches have a series of teeth that successively cut the work to the required form, and naturally the proportioning of these teeth is one of the most important features of broach design. While the design of a broach, aside from its general shape or form, depends largely upon its intended use, there are certain features which apply to broach-making in general. One of the first things to determine is the pitch of the teeth, or the distance from one tooth to the next.

Pitch of Broach Teeth

As a general rule, the pitch P (see Fig. 1) should increase as the length of the hole increases to provide sufficient space between the teeth for the chips. The pitch of the teeth

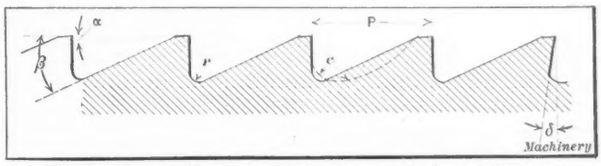


Fig. 1. Diagram illustrating Pitch, Clearance Rake and Filleting

for broaching under *average* conditions can be determined by the following formula, in which P = pitch of teeth and L = length of hole to be broached:

$$P = \sqrt{L} \times 0.35$$

This formula expressed as a rule would be: *The pitch of the teeth equals the square root of the length of the hole multiplied by the constant 0.35.* For example, if a broach is required for a square hole 3 inches long, the pitch of the teeth would equal $\sqrt{3} \times 0.35 = 0.6$ inch, approximately.

Of course a given pitch will cover quite a range of lengths, the maximum being the length in which the chip space will be completely filled. The constant given in the preceding formula may be as low as 0.3 for some broaches and as high as 0.4 for others, although the pitch obtained with the value 0.35 corresponds closely to average practice. When a broach is quite large in diameter, thus permitting deep chip spaces in front of the teeth, the pitch might be decreased in order to reduce the total length of the broach. On the other hand, if the work is very hard and tough, a coarser pitch might be advisable in order to reduce the power required to force the broach through the hole. If the pitch is too fine in proportion to the size of the broach, there may be difficulty in hardening, owing to the fact that the fine teeth will cool much more rapidly than the broach body, thus

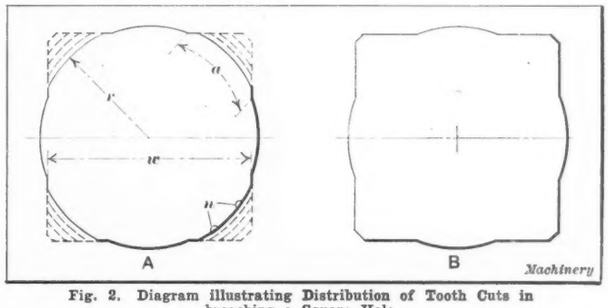


Fig. 2. Diagram illustrating Distribution of Tooth Cuts in broaching a Square Hole

producing severe strains which tend to crack the teeth, especially at the corners. If the teeth are too closely spaced, so much power may be required for drawing the broach through the work that there is danger of pulling the broach apart. In general, the pitch should be as coarse as possible without weakening the broach too much, but at least *two teeth should be in contact* when broaching work of minimum length.

Depth of Cut per Tooth

The amount of metal that the successive teeth of a broach should remove, or the increase in size per tooth, depends largely upon the hardness or toughness of the material to be broached. The size of the hole in proportion to its length

* Associate Editor of MACHINERY.

also affects the depth of cut, so that it is impossible to give more than a general idea of the increase in size per tooth. Medium-sized broaches for round or square holes usually have an increase of from 0.001 to 0.003 inch per tooth for broaching steel, and approximately double these amounts for soft cast iron or brass. Large broaches up to 2 or 3 inches may have an increase of from 0.005 to 0.010 inch per tooth. Obviously, the depth of cut is governed almost entirely by the nature of the work. For example, a small broach for use on brass or other soft material might have a larger increase per tooth than a much larger broach for cutting steel. If the amount of metal to be removed is comparatively small and the broach is used principally for finishing, the increase per tooth may not be over 0.001 inch even for large broaches.

The diagrams *A* and *B*, Fig. 2, show a common method of broaching square holes in the hubs of automobile transmission gears, etc. Prior to broaching a hole is drilled slightly larger in diameter than the square width. The first tooth on the broach is rounded considerably and cuts a long circular chip, as indicated at *a*, and the following teeth form the square corners by removing successive chips (as shown by the dotted lines) until the square is finished as at *B*. As will be seen, the first tooth has the widest cut, the chip width *a* greatly decreasing toward the finishing end of the broach. Hence, if this hole were finished with a single broach, it would be advisable to vary the sizes of the teeth so that the depth of cut gradually increases as width *a* decreases. It is good practice to nick some of the wide teeth as indicated at *n*, in order to break up the chips, as a broad curved chip does not bend or curl easily. In case two or more broaches are required, the first broach of the set may have a uniform variation in the radii *r* of different teeth, but the depth of cut should be less than for the following broaches which remove comparatively narrow chips from the corners of the square. Several end teeth, especially on the last broach of a set, are made to the finish size. This feature, which is common to broaches in general, aids the broach in retaining its size and tends to produce a more accurately finished hole.

Testing Uniformity of Teeth

When testing a broach to determine if all the teeth cut equally, first use a test piece not longer than 2 × pitch of teeth. Pull the broach through and note the amount of chips removed by each tooth; then "stone down" the high teeth and test by drawing through a longer piece, and, finally, through the full length required. If a broach is warped much, or is otherwise inaccurate, some teeth may take such deep cuts that the broach would break if an attempt were made to pull it through a long hole on the first trial.

Clearance Angles for Broach Teeth

The clearance angle α (Fig. 1) for the teeth of broaches is usually very small, and some broaches are made with practically no clearance. Ordinarily there should be a clearance angle varying from 1 to 3 degrees, 2 degrees being a fair average. A common method of providing the necessary clearance is as follows: All the lands of the hardened broach are first ground parallel and then they are "backed off" slightly by means of an oilstone. Just back of the narrow land (which may not be over 1/32 inch wide) there is a clearance of 2 or 3 degrees, machined prior to hardening.

The clearance space required for the chips depends upon the length of the hole and the depth of the cut. When the cut is light, and especially if the material to be broached is tough, thus making it necessary to use as strong a broach as possible, the clearance space should be proportionately small. The fillet at the base of each tooth should have as large a radius *r* (Fig. 1) as practicable and the grooves between the teeth should be smooth so that the chips will curl easily. A curved clearance space, similar to that indicated by the dotted line *c*, is superior to the straight slope, although not so easily machined. The front faces of the teeth are sometimes given a rake δ of from 5 to 8 degrees so that the broach will cut more easily and require less pressure to force it through the holes.

Steel for Broaches

Three kinds of steel are used for making broaches: namely, alloy steel, carbon steel and, to some extent, casehardened machine steel. Carbon-vanadium tool steel is especially adapted for broaches. This steel differs from the high-speed steels in which vanadium is also used in that it does not contain tungsten or chromium, but is simply a high-grade carbon steel containing a certain percentage of vanadium. The addition of vanadium to carbon steel imparts certain qualities, the most important of which are, first, the higher temperature to which the steel can be heated without coarsening the grain (thus permitting a greater range in temperature for hardening without spoiling the tool), and second, the tough core which makes the broach stronger and more durable than one made of regular high-carbon steel. The makers recommend hardening carbon-vanadium steel at a temperature varying from 1350 to 1425 degrees F., the temperature depending somewhat upon the size of the tool. The steel is then drawn to suit conditions, the drawing temperature generally being about 460 degrees F. This particular brand of steel will not harden in oil.

Regular carbon steel that is used for broaches should have from 1.00 to 1.10 per cent carbon. To prevent the steel from warping excessively, the broach should be annealed after the teeth have been roughed out. A successful method of hardening to prevent excessive warping is as follows: After machining the broach and before hardening, heat to a dark red and allow the broach to cool while lying on a flat plate, then heat to the hardening temperature and harden in the usual manner. This method, which is applicable to all tool steels, reduces warping to a minimum and is of especial value when hardening slender broaches.

Straightening Hardened Broaches

Broaches that have been warped by hardening can be straightened at the time the temper is drawn. Place the broach on two wooden blocks on the table of a drill press equipped with a lever feed, and insert a wooden block in the end of the drill press spindle. Heat the broach with a Bunsen burner until the hand can barely touch it; then apply pressure to the "high" side. Continue heating (as uniformly as possible) and bending until the broach is straight, but complete the straightening operation before the broach has reached a temperature of about 350 degrees F., so that the drawing temperature will not be exceeded. With this method the heat required for straightening is also used for drawing the temper, the broach being removed and quenched as soon as the tempering temperature is reached. The temperature is judged by brightening some of the teeth throughout the length of the broach and watching the color-changes as the temperature increases.

* * *

THE COUNTRY BLACKSMITH AND THE AUTOMOBILE

The rapid increase of automobile users in the agricultural districts has brought to the country blacksmiths a class of repair work which many are poorly fitted to handle. The ordinary horseshoer has little conception of the proper procedure to follow when called upon to straighten a bent channel section frame, for example, and much time and hammering are expended in accomplishing what proper heating and a few successful blows would otherwise quickly perform. The result is high cost for unsatisfactory repair work.

The country blacksmith should become familiar with the peculiarities of beam sections generally and with the construction of gas engines, frames, wheels, crankshafts, clutches, springs, etc. He should, in short, become an all-around mechanic of good judgment and quick action if he is to embrace the opportunity offered to the shops in good locations. The opportunity for the progressive man in many localities is golden. He must equip his shop with a few machines and apparatus not required for horseshoeing and repair of farm machinery, but the returns will amply reward him for the investment.

INSPECTION TESTS FOR CINCINNATI GEAR-CUTTING MACHINES

METHODS OF TESTING ALIGNMENT OF DIFFERENT PARTS WHILE GEAR-CUTTING MACHINES ARE BEING ASSEMBLED

The accuracy required for gearing necessitates a very close inspection of gear-cutting machines when erecting and of the machining operations of various parts. In most cases where gears are found to be defective, the fault lies in the imperfect machining of the gear blank rather than in the machine itself. As it is difficult to turn a gear blank so that it will run absolutely true after it has been removed from the mandrel and put back again in a reversed position, it is not strange that imperfect gears are commonly due to inaccurate blanks or improper mounting on the gear-cutting machine. When the blanks are accurately machined and properly mounted so as to avoid springing while being cut, gears can be finished very accurately in a properly built machine.

The illustrations shown herewith indicate the methods employed by the Cincinnati Gear Cutting Machine Co. Cincinnati, for testing the alignment of different parts while the gear-cutter is being assembled. The top of the machine bed is used as the foundation from which the tests are started. Upon this accurate surface a square column *A* is placed, as illustrated in Fig. 1. The sides of this column are parallel and perpendicular to the broad base which rests upon the ways. By turning this column and using its different sides, it is possible to determine accurately whether the face of the housing is perpendicular to the bed, the dial indicator *C* being placed upon the housing both at the top and bottom. When the housing is found to be perpendicular, the next inspection (shown in Fig. 2) is to determine the parallelism of the face of the outer support *B* with the housing face. The indicator *C* is attached to the spindle and the test is made by traversing the spindle-head vertically and noting any variation as indicated by the dial gage.

The hole in the work-spindle is next tested, as shown in Fig. 3, to determine whether it is concentric with the outside of the spindle and also whether its axis is parallel with the bed. The accuracy of the hole is determined by inserting the test-bar *D* in the spindle and revolving the latter while the dial gage is in contact with the bar. On the bottom of the indicator stand there is a block which comes against the inside edge of the bed, so that by placing the indicator in different positions along the top of the bed the parallelism of the spindle (as shown by test-bar *D*) can be determined.

The tests for the over-arm and centers that are used when cutting small gears are indicated in Figs. 4 and 5. These tests are similar to that employed for the work-spindle and are self-explanatory. After the truth of the work-spindle is determined, it is used as a tram, as shown in Fig. 6, to see if the ways of the cutter-spindle slide are at right angles to the work-spindle. A special angular surface-plate *E* is inserted in the dovetail ways and the indicator *C* is attached to an arbor and is swung from one side to the other by turning the spindle, thus bringing it into contact with op-

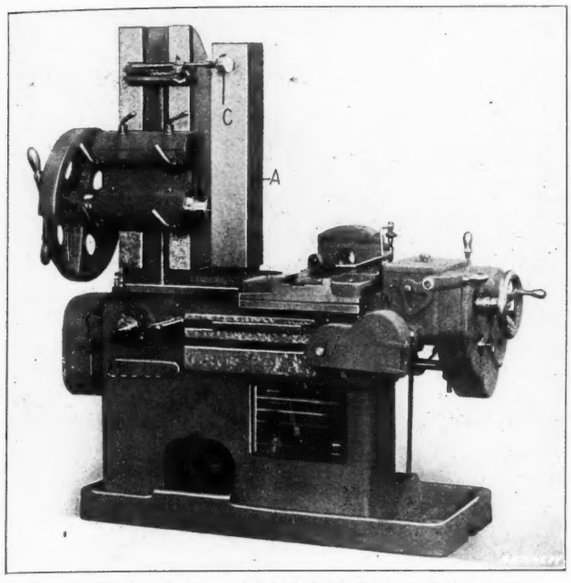


Fig. 1. Testing Position of Spindle-head Column relative to Base

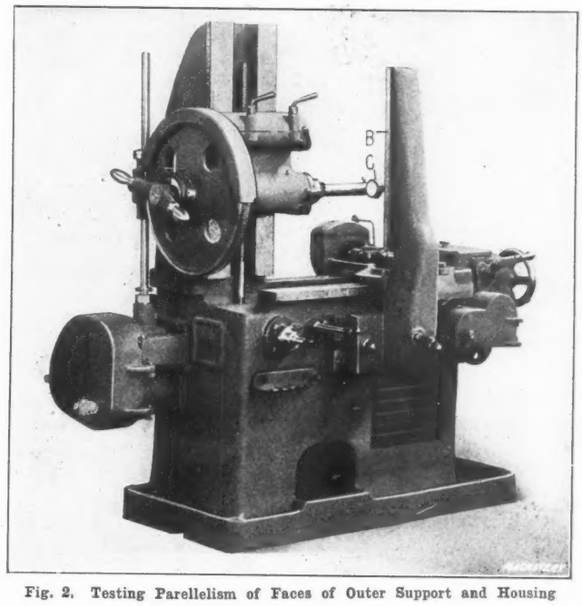


Fig. 2. Testing Parellelism of Faces of Outer Support and Housing

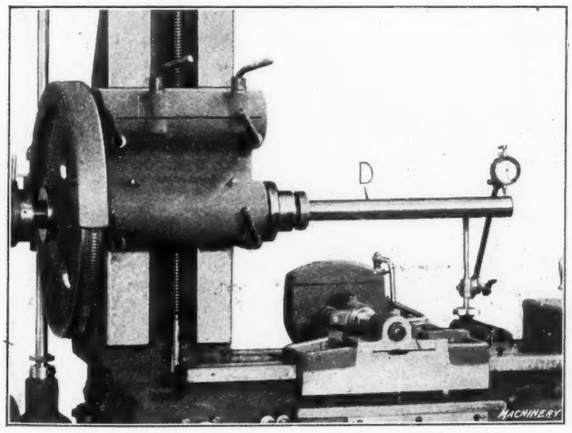


Fig. 3. Testing Concentricity of Hole in Work-spindle

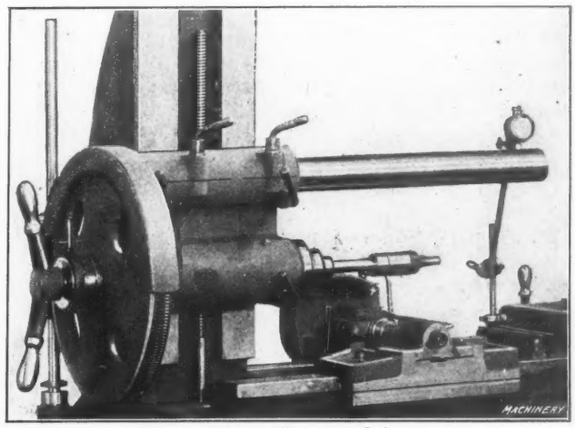


Fig. 4. Testing Alignment of Over-arm

posite ends of the surface-plate. The cutter-arbor is tested as shown in Fig. 7 to determine whether it is parallel with the top of the bed and also whether it runs concentric with the cutter-spindle. In making this test, the indicator base rests upon the top of the bed, as shown.

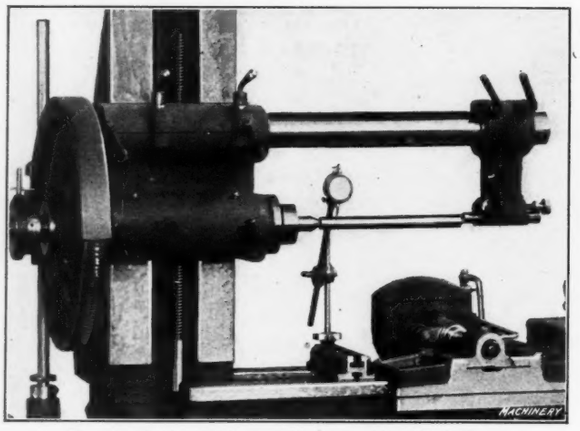


Fig. 5. Testing Centers used when cutting Small Gears

The test of the elevating screw is illustrated in Fig. 8. This is effected by using different blocks of a known length and comparing these blocks with the readings on the dial of the machine. The test indicator is first brought into contact with one of the blocks *B* and its dial is set at zero. The

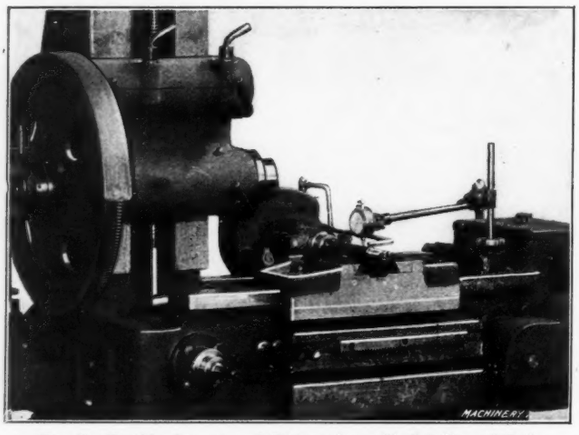


Fig. 7. Testing Accuracy of Cutter-arbor with Spindle and Bed

spindle-head is then elevated a distance equal to the difference between the length of block *B* and the next one to be used. The longer block is then placed under the test indicator and any variation of the pointer from zero shows the error in the elevating screw. The outer supporting arm for the

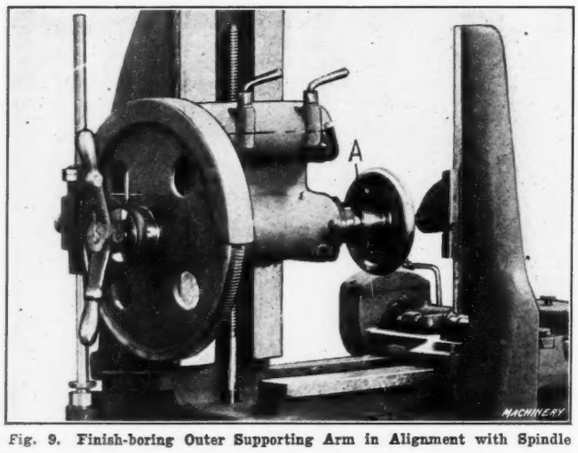


Fig. 9. Finish-boring Outer Supporting Arm in Alignment with Spindle

work-arbor is rough-bored prior to erection, but the finish-boring is done as shown in Fig. 9. The work-spindle and boring-bar are revolved by a small motor (not shown) belted to the index wormwheel which is temporarily converted into a pulley by placing a rim over it. The feed of the cutter-bar is effected by holding wheel *A* stationary. The truth of the bored hole is tested as illustrated in Fig. 10.

The method of testing the accuracy of the index worm-wheel is shown in Fig. 11. Two disks *D* and D_1 are placed

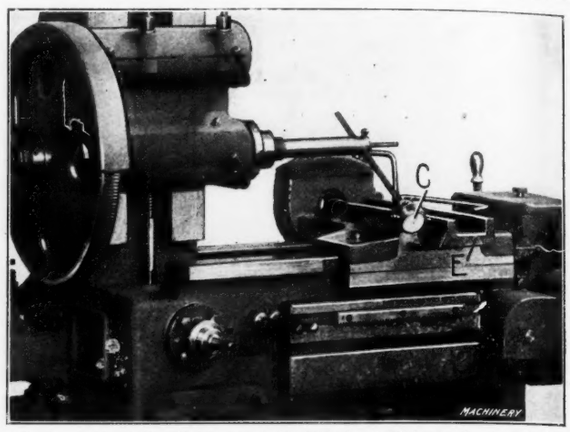


Fig. 6. Determining if Cutter-spindle Slide is at Right Angles to Spindle

side by side on a "floating" arbor. This floating arbor compensates for any slight error in the periphery of the disks, and by means of a knife-edge scriber fine lines are scratched across these two disks. This is done with the machine belted for use, and the operation is practically the same as if a

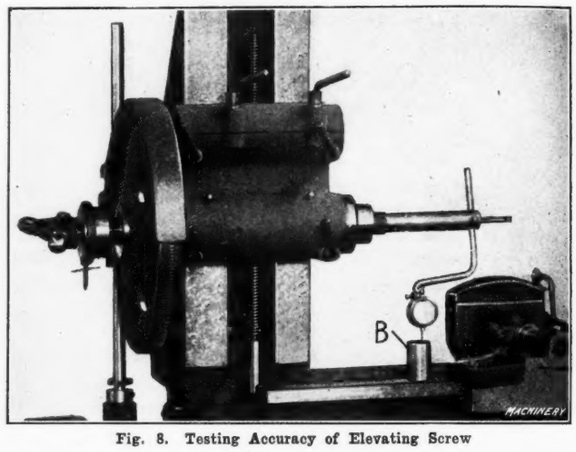


Fig. 8. Testing Accuracy of Elevating Screw

gear were being cut. After the disks have made a complete revolution, one of them is revolved half a turn in order to double any indexing error that may exist. As these disks are 18 inches in diameter, the error found in this way would be the same as though a 36-inch solid disk were used. After

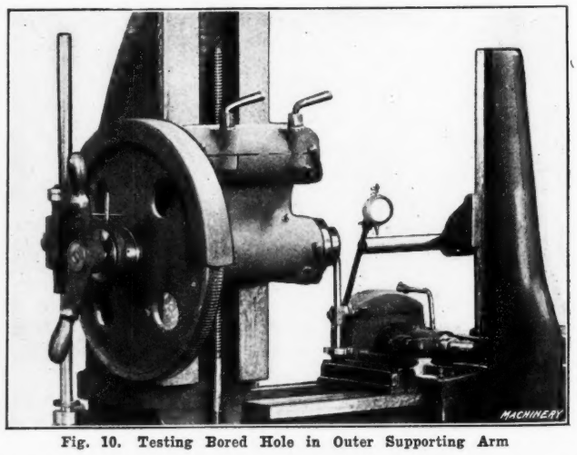


Fig. 10. Testing Bored Hole in Outer Supporting Arm

one disk is turned a half revolution, a comparison is made with the lines on the stationary disk by the aid of a microscope and a thin strip of metal upon which there are a thousand lines to the inch. Under the microscope, the thou-

sandth inch appears almost like one-sixteenth inch, so that very slight errors are easily observed.

An accurate means of setting the cutter centering device is shown in Fig. 12. A disk D having an included angle of 60 degrees is placed on the cutter-arbor and another disk D_1, notched to a corresponding angle, is placed on the work-arbor.

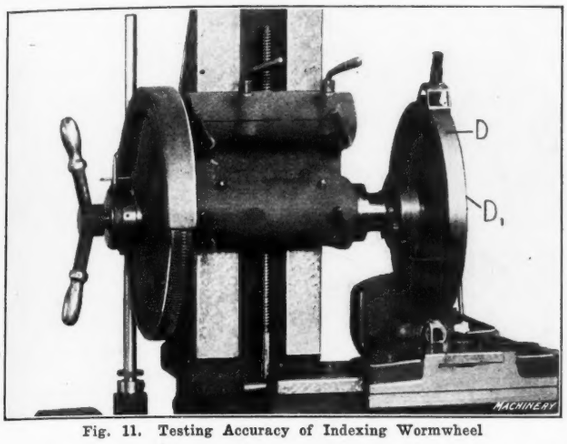


Fig. 11. Testing Accuracy of Indexing Wormwheel

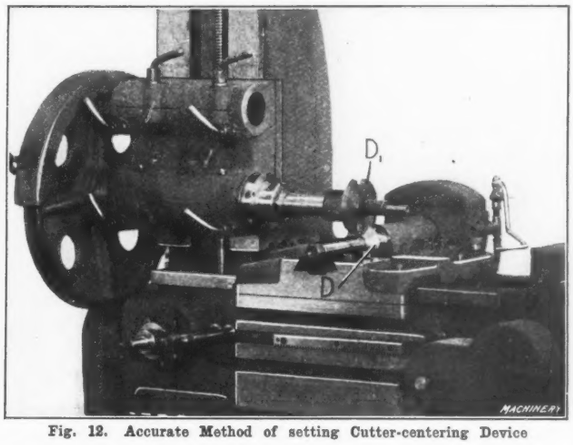


Fig. 12. Accurate Method of setting Cutter-centering Device

The disk on the cutter-arbor is adjusted to such a position that all light is excluded between it and disk D_1 on the work-arbor; then the latter is reversed and if the light is still excluded this indicates that the disk on the cutter-arbor is central with the work-arbor and it is then used for setting the center gage.

F. D. J.

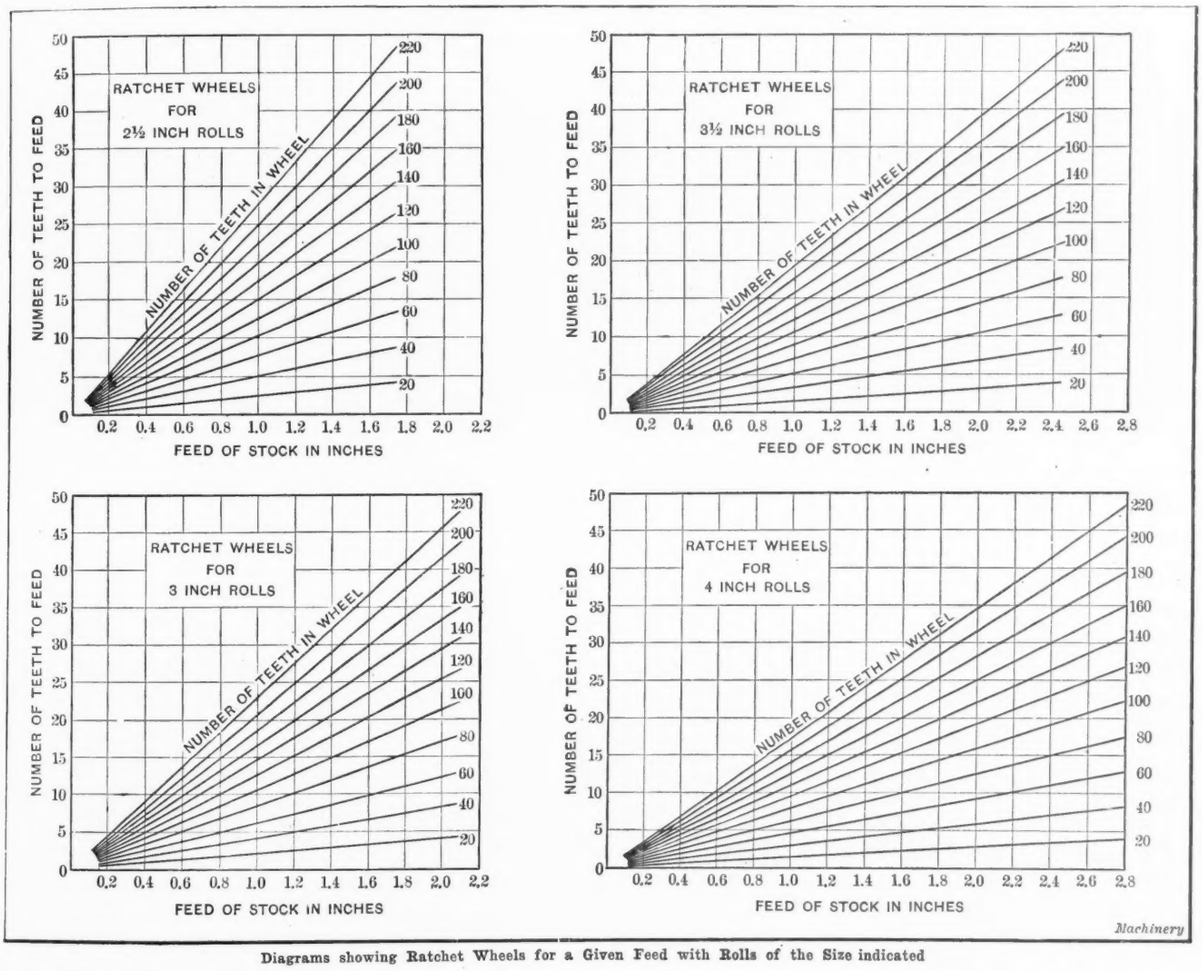
* * *

Engineers who have returned from Spitzbergen after constructing the Norwegian Government's wireless station express the view that the natural resources on the islands are much more valuable than is generally supposed.

RATCHET WHEELS FOR FEED ROLLS

BY SIDNEY C. CARPENTER*

When selecting ratchet wheels for the feed rolls of power presses, the diameters of the rolls on the machine and the feed of the stock which is required are usually known, and the problem is to select a suitable wheel from the assortment in stock and then to determine the number of teeth on this wheel which corresponds with the required feed. For this purpose, the writer has compiled the diagrams shown herewith and has found that they save a considerable amount of time when a problem of this sort comes up. A complete list of the wheels that can be used for a given feed may be quickly obtained by following the vertical line corresponding with the required feed. As an example, let us suppose that a feed of 1.4 inch is required with feed rolls 2½ inches in diameter.



Diagrams showing Ratchet Wheels for a Given Feed with Rolls of the Size indicated

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Following the vertical line from 1.4 on the diagram for 2½ inch rolls—referring at each diagonal to the "number of teeth to feed" column at the left-hand side of the diagram—the following list of wheels is quickly obtained:

Wheel	Feed
40	7 teeth
80	14 "
120	21 "
160	28 "
200	35 "
220	39 "

If double pawls are used, half teeth can be read directly from the diagram.

A leading press manufacturer gives the practical limit for the feed of the stock as 0.7 of the diameter of the roll, which figures out about 0.22 of the number of teeth in the ratchet wheel. The limit for the different wheels in the diagrams is based upon this proportion. If a larger feed is required, gearing may be interposed between the ratchet and the rolls to give the required result. The diagrams give the principal relation between the feed of the stock in inches, the number of teeth in the wheel, and the number of teeth to feed for feed rolls of 2½, 3, 3½, and 4 inches in diameter. They are figured from the following formulas:

$$F = \frac{tC}{T} \qquad T = \frac{tC}{F} \qquad t = \frac{TF}{C} \qquad C = \frac{TF}{t}$$

in which C = circumference of feed roll;
T = number of teeth in ratchet wheel;
t = number of teeth to feed;
F = feed of stock in inches.

Similar diagrams for other sizes of feed rolls can be easily figured from these formulas.

* * *

SHOP PROBLEMS INVOLVING THE USE OF THE PRONY BRAKE FORMULA*†

BY J. H. CARVER‡

A convenient form of the prony brake formula is:

$$\text{H. P.} = 0.000016\ TN$$

where H. P. = horsepower transmitted;
T = twisting moment $(P \times R)$;
N = number of revolutions per minute.

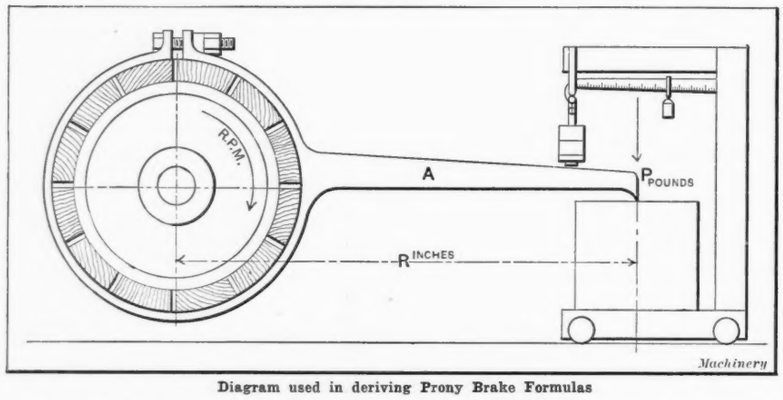

Diagram used in deriving Prony Brake Formulas

It is derived from the accompanying illustration, where it will be evident that if arm A makes N revolutions per minute, then a point R inches from the center travels $\frac{2\pi RN}{12}$ feet per minute. If P pounds are registered on the scale beam, the amount of power being developed is:

$$\frac{2\pi RN}{12} \times P = 0.5236\ PRN \text{ foot-pounds per minute.}$$

Therefore, as 33,000 pounds acting through a distance of one foot in one minute means one horsepower, then the horsepower transmitted is:

$$\text{H. P.} = \frac{0.5236\ PRN}{33{,}000} = 0.000016\ PRN \qquad (1)$$

Where it is convenient to use the twisting moment, $T = PR$, then:

$$\text{H. P.} = 0.000016\ TN \qquad (2)$$

In many instances, problems arise where the following formulas may be used to good advantage.

$$T = \frac{63{,}000 \text{ H. P.}}{N} \qquad (3) \qquad N = \frac{63{,}000 \text{ H. P.}}{T} \qquad (4)$$

$$P = \frac{63{,}000 \text{ H. P.}}{RN} \qquad (5)$$

These are derived from the equations:

$$\text{H. P.} = \frac{0.5236\ PRN}{33{,}000}$$

$$PR = T = \frac{33{,}000 \text{ H. P.}}{0.5236\ N} = \frac{63{,}025 \text{ H. P.}}{N}$$

(Neglecting 25 in the numerator.)

The following examples explain the use of the diagrams presented in the current Data Sheet Supplement.

$$\text{H. P.} = 0.000016\ PRN \qquad (1)$$

$$\text{H. P.} = 0.000016\ TN \qquad (2)$$

A hand-operated geared crane has a crank on each end of its driving shaft. Two men each exert a pressure of 50 pounds at a distance of 24 inches from the center of this shaft and turn it at 70 R. P. M. for a short period. If operated by a motor, what horsepower is necessary? T = twisting moment or torque of motor = $100 \times 24 = 2400$ inch-pounds.

Then H. P. = $0.000016 \times 2400 \times 70 = 2.68$ H. P.

Using Diagram No. 1 and starting downward from 70 R. P. M. to the 100-pound diagonal and then moving to the right, stopping at the 24-inch line, and then downward gives 2.7 H. P. Therefore, allowing a possible 50 per cent overload on the 2.7 H. P. shows that a 4 H. P. motor is necessary, 5 being the nearest probable commercial rating obtainable.

$$T = \frac{63{,}000 \text{ H. P.}}{N} \qquad (3)$$

A motor pulley 20 inches in diameter is running at 500 R. P. M. Find the torque of motor when it is delivering 20 H. P. Using Diagram No. 2, start at 20 H. P. upward to the 10-inch diagonal; then move to the left, intersecting the vertical coming down from 500 R. P. M. at a point on the 250-pound diagonal. This point of intersection shows 250 pounds pressure on a 10-inch radius or a torque of 2500 inch-pounds.

$$N = \frac{63{,}000 \text{ H. P.}}{T} \qquad (4)$$

What speed is necessary for a shaft having a twisting moment of 16,000 pounds to give 70 H. P. (20×800 gives T, the twisting moment.) Start from 70 H. P. at the bottom of Diagram No. 3 and stop at the 20-inch diagonal; then moving to the left to the 800-pound line and upward shows 275 R. P. M. as speed necessary. (Figures show 275.6 R. P. M.)

$$P = \frac{63{,}000 \text{ H. P.}}{RN} \qquad (5)$$

It is required to find the tooth load on a 35 H. P. motor pinion running at 600 R. P. M. where the pitch diameter of the pinion is 12 inches. On Diagram No. 3, starting upward from 35 H. P. to the 6-inch diagonal, then moving to the left, intersecting the vertical downward from 600 R. P. M. shows approximately 610 pounds load. (Figures give 612.5 pounds.)

A scale used in connection with a prony brake registers 200 pounds. The lever arm is 5 feet long and the speed of the gas engine being tested is 600 R. P. M. What horsepower is being transmitted? Using Diagram No. 4 and starting downward from 600 R. P. M., stopping at the 200-pound diagonal, then moving to the right to the 60-inch line and downward again, gives 115 horsepower.

* With Data Sheet Supplement
† See also "Calculating Horsepower from Dynamometer Tests," August, 1911, engineering edition.
‡ Address: Care of General Electric Co., Schenectady, N. Y.

HARDENING AND TEMPERING STEEL

A REVIEW OF THE GENERAL REQUIREMENTS AND CHARACTERISTICS OF QUENCHING AND TEMPERING BATHS

While there have been many articles published regarding the hardening and tempering of steel and the furnaces used, there is but little detailed information available regarding the baths used for these operations. The time has long since passed when each hardener had his own carefully guarded secrets regarding the composition of quenching baths. On the other hand, the time has also passed when it was a common belief that to harden a piece of steel it was only necessary to cool it off more or less rapidly in almost any kind of cooling medium; it has been found that the cooling mediums for hardening and the heating mediums or baths for tempering do, after all, play quite an important part both as regards economy and the efficiency of the tools treated. It is the intention in this article to outline the methods which have proved most successful, and to give the compositions of baths which from long experience in connection with hardening operations have proved to give the best all around results and to be the most economical; in many cases they have not been the cheapest in initial cost, but nevertheless are most economical because of the better results obtained with the tools treated and the greater length of time that the baths could be used before deteriorating. A description of such receptacles—cooling tanks and tempering furnaces—for the treatment of steel as have proved to be the best for all around purposes has also been included.

For the sake of convenience the subject will be divided into four distinct parts as follows: (1) Baths used for cooling (quenching). (2) Baths used for tempering (drawing the temper after hardening). (3) Some tests and analysis of baths referred to under (1) and (2). (4) Receptacles and furnaces used in quenching and tempering.

Characteristics of Quenching Baths

No matter what the composition of a quenching bath, to insure uniform hardening the temperature of the bath must

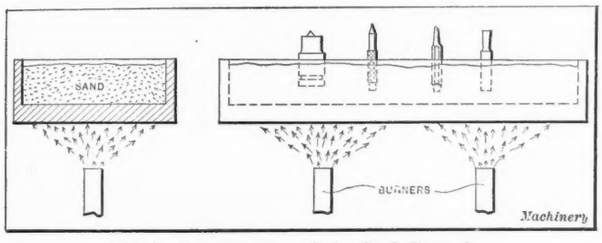

Fig. 1. Arrangement used for Sand Tempering

be kept constant, so that successive pieces of steel or tools quenched will be acted upon by baths of the same heat. The necessity of a uniform temperature for a quenching bath will be readily understood by reference to ordinary water for a cooling bath; everyone having any knowledge of the subject knows that a tool quenched in such a bath at room temperature will come out much harder than if quenched when the water is at the boiling point. In fact, it is well known that one way of partially annealing steel is by plunging it at a red heat into hot water. The same difference in hardness will result when using any quenching bath at different temperatures, and hence no actual and dependable data can be obtained unless means are taken for keeping these baths at a uniform heat.

When using quenching baths of different composition the tools quenched will vary in hardness. This is due mainly to the difference in heat-dissipating power of the different baths. Thus a tool hardened at the same temperature in water and brine will come out harder when quenched in brine; the greater the conductivity of the bath the quicker the cooling. The general opinion, today, is that the composition of a quenching bath is of small importance as long as the bath cools the pieces rapidly. Those who have made a study of the subject have found different opinions regarding the same quenching bath by different users, and a good many quenching fluids have been condemned owing to improper heating and in many cases to improperly built furnances. As an example may be cited an oven furnace with which the user once had trouble. Owing to faulty construction of this furnace, more air was let into the heating chamber of the furnace than could be taken care of by the fuel oil; after having condemned first the steel and then the quenching bath, and then trying one quenching bath after another with the same results, it was suggested that the "heating" did not look just right, and an expert was called in to find out what the trouble was. After much experimenting with

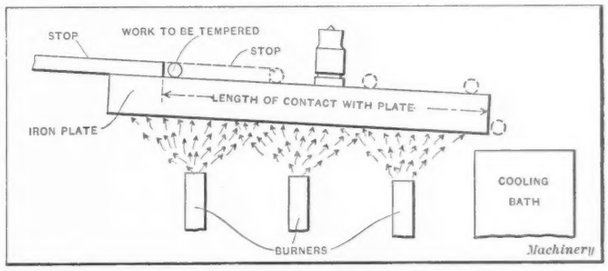

Fig. 2. Tempering Arrangement utilizing an Inclined Plate on which the Objects roll down

the burners and the furnace itself good results were finally obtained. The difficulty seemed to be that the oxygen of the air attacked the steel and formed oxide of iron on the surface of the tools, which consequently had a soft scale on the outside.

Those who are skeptical as to there being any difference in the effect on steel of cooling baths of different composition will readily admit that it is advantageous to use baths free from oxygen and from ingredients that tend to oxidize. Quenching baths should be uniform; good tool steels of high carbon are very sensitive to differences in both water and oils. Water for hardening tool steel should be soft; entirely different and very unsatisfactory results will be obtained when using hard water. While different quenching oils show less difference in the results obtained, vegetable and animal oils will give somewhat different degrees of hardness depending upon the sources from which they are obtained. One cannot be too careful in the selection of water, as it is likely to contain many impurities. If it contains greasy matters, it may not harden steel at all, whereas if it contains certain acids, it will be likely to make the tools quenched in it brittle and even crack them.

List of Quenching Baths

(1) Water—soft—preferably distilled; good tool steel should require no mixture added to pure water. (2) Salt added to water; will produce a harder "scale" than if quenched in plain water. (3) Sea (salt) water—the keenest natural water for hardening. (4) Water as under (1), containing soap. (5) Sweet milk.* (6) Mercury.* (7) Carbonate of lime.* (8) Wax.* (9) Tallow.* (10) Air—mostly used for high-speed steel; mere exposure, however, is in many cases and on many steels not sufficient to produce hardness and an air blast is necessary, as this furnishes cool air in rapid motion. (11) Oils† such as cottonseed, linseed, whale, fish, lard, lard and paraffine mixed, special quenching oils, etc.

The following list of oils and names of firms supplying them is given for the sake of convenience. The firms mentioned are reliable and their oils have been thoroughly tried out in comparison with other makes and have proved to be superior; opinions may, of course, differ in this respect and no doubt there are many oils that have not been tried that may be as good.

Cottonseed oil—Union Oil Co., Providence, R. I.; Underhay Oil Co., Boston, Mass.

* Generally used for special purposes only.
† A small quantity of sal-ammoniac added to the oil bath has a tendency to make the tools come out clean from the bath.

Linseed oil—Spencer Kellogg & Sons, Inc., Buffalo, N. Y.

Whale oil—no difference found between two different kinds.

Fish oil—only one kind tried.

Lard oil—W. B. Bleecker, Albany, N. Y.; E. F. Houghton & Co., Pittsburg, Pa.

Paraffine oil—Underhay Oil Co., Boston, Mass.

Special quenching oil—E. F. Houghton & Co., Pittsburg, Pa. Very good and cheap. While this may possibly deteriorate somewhat faster than some of the others mentioned it will prove very economical.

The order of the intensity with which various cooling baths will harden steel of about 0.90 to 1.00 per cent carbon is as follows: Mercury, carbonate of lime, pure water, water containing soap, sweet milk, different kinds of oils, tallow and wax. In all cases, except possibly the oils, tallow and wax, it must be remembered that the tools become harder as the temperature of the bath becomes lower.

Baths used for Tempering

The object of tempering is to reduce the hardness and to remove internal strains caused by sudden cooling in quenching. The composition of a tempering bath is of little importance compared with that of a quenching bath when considering the effect upon the pieces treated. Aside from the operator's convenience and possible bad effects upon his health, the different baths used for this operation must be considered with regard to initial cost, lasting quality, effects on finish, etc.

While oil is the most widely used medium for tempering tools in quantities, other means and methods are employed, especially by those who have tools in small quantities to temper, when the expense of installing and running an oil tempering furnace would not be warranted. Of these methods we first find the one used by the old-style tool hardener of only partly cooling the tool when quenching it, then quickly withdrawing it, polishing off the working surface, and then letting the heat which remains in the tool produce the required temper as judged by the color. If the tool has a shank, it is good practice to heat part of the shank also and quench the working part of the tool only, in which case this part can be cooled off thoroughly; the heat remaining in the body or shank of the tool will do the tempering, which also in this case must be judged by the color.

The sand bath is another frequently used medium for tempering, the sand being deposited on an iron plate and heated; by the use of this method a piece to be tempered can be given different tempers throughout its length, as, for example, rivet hole punches; these are placed endwise—bottom down—in the sand about two-thirds projecting outside the sand into the air (see Fig. 1). It is readily seen that the nearer the bottom of the sand bath, the higher the heat, and the punch so placed, when tempered right, will have the bottom soft—a deep dark blue—the neck a very dark straw, and the working part of the punch on top a light straw color; thus there is a gradual increase in hardness from the bottom up. Pieces so drawn must previously have been polished, and the temper is judged by the color. When the pieces have attained the right color they are, of course, cooled off, generally in water or oil. A plate without sand similarly heated can also be used, but it is not as satisfactory.

A plate arranged as shown in Fig. 2 will be found very convenient when drawing small, round pieces. The pieces are rolled on the inclined plate which is heated as indicated. The length of time the work is in contact with the plate can be regulated by adjusting the amount of the incline, as well as the location of the "stop." This arrangement can also be used for such work as punches, etc., in which case the plate, of course, should stand level and not in an inclined position.

Another frequently used tempering medium is hot air, the temper in this case also being judged by the color. For this method of tempering special furnaces should be employed in order to get uniform results. This method is used more especially for small and light work in quantities and where the color has to be bright and clear. While all of these methods have the advantage of enabling one to actually see the temper given to tools treated, the oil tempering bath is the one mostly used owing to its economy.

The two main points to be considered when using an oil tempering furnace are: first, to have the heat uniform throughout (not hotter where the burners or flames are in contact with the walls of the furnace); and second, to leave the pieces to be tempered in the oil long enough to have attained the heat of the oil throughout when taken out. The first point can be taken care of, as far as possible, by proper construction of the furnace; the second can best be taken care of by immersing the pieces to be tempered in the oil before starting to heat, and letting the pieces remain in the oil and be heated with it to the temperature required. In such a case, one should, of course, have more than one furnace, or else after each operation take the hot oil out and refill the tank with cold. The method described is very much better than the one frequently used of immersing the pieces in a bath which already has the required temperature and then letting them remain long enough to attain the heat of the bath throughout, as a furnace yet has to be designed which will maintain a uniform heat for even as short a time as is required for this operation. Furthermore, it is not necessary that a piece to be tempered be held in the bath a certain length of time at the required temperature; the temperature desired need only be maintained long enough to insure that the piece has been evenly heated throughout.

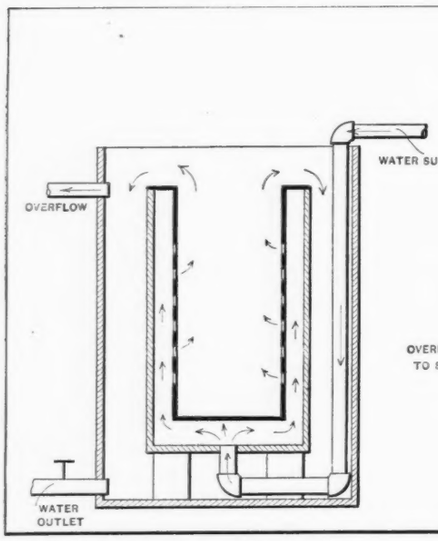

Fig. 3. Water or Brine Tank for Quenching Baths

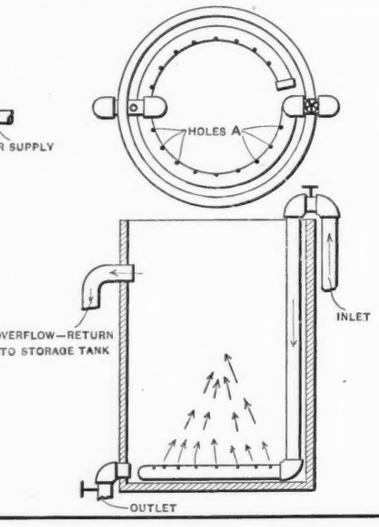

Fig. 4. Another Type of Water or Brine Tank

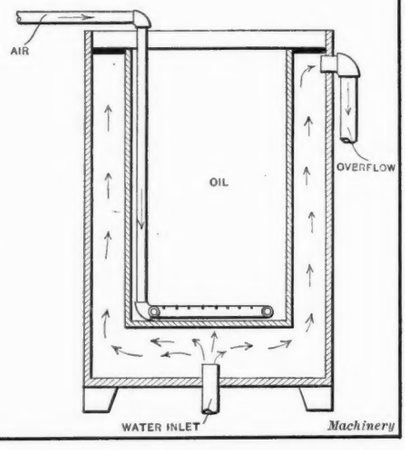

Fig. 5. Oil-quenching Tank with Water circulated in an Outer Tank

When tempering to high heats, or, rather, when tempering to higher heats than the flash point of any tempering oils (650 to 700 degrees F.*) some other tempering fluid than oil must be used. Lead is the one usually employed. As it is impossible when using lead to let the pieces to be tempered be heated up with the lead, they must be immersed at the predetermined temperature and kept there until heated evenly throughout to the same temperature as the lead. It is claimed by many that it is easier to maintain a uniform heat in a lead bath than in an oil bath, but it has been found that,

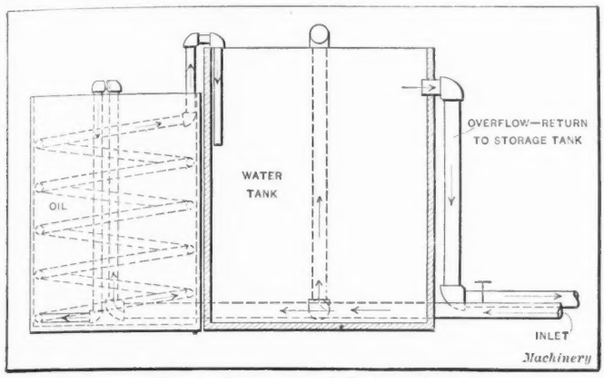

Fig. 6. Water and Oil Tank Combined

owing to the lead not circulating as readily, the temperature may vary considerably in different parts of the bath, and hence it is not very reliable.

Salt is another medium frequently employed for tempering heats between 575 and 875 degrees F. Salt fuses at 575 degrees F., but when immersing the pieces to be tempered the salt will immediately solidify around the cold pieces. When these are heated to 575 degrees, the salt will melt and the pieces should be withdrawn. This is not reliable, however, as the pieces, especially if large, will not have had time to be heated through before the salt melts. If a higher temper

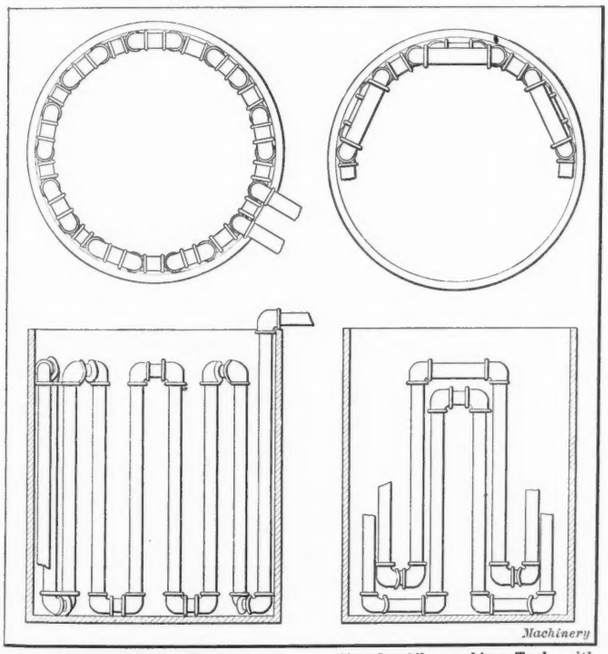

Fig. 7. Ordinary Type of Quenching Tank

Fig. 8. Oil-quenching Tank with Water and Steam Coils

is required, it is, of course, only necessary to let the pieces remain in the bath and get the readings of the heat from a pyrometer. In all these methods, it is questionable if it is good practice to suddenly immerse cold pieces to be drawn into baths of such high temperatures. When a lower temper is required, and an oil tempering bath or furnace is not available, alloys of lead and tin can be used for as low heats as

* There are tempering oils on the market claimed to have a flash test of 750 degrees, but it is doubtful if they ever have been found to stand this test. Heavy black cylinder oil has been found to stand a flash test of 725 degrees.

400 degrees and of lead and antimony for 500 degrees. However, this involves the inconvenience of keeping a large number of different alloys on hand, if it is desired to vary the temper heats. The following table for different alloys which melt at the temperatures given was compiled by Mr. O. M. Becker.

Lead	Tin	Melting Temperature, Degrees F.	Lead	Tin	Melting Temperature, Degrees F.
14	8	420	24	8	480
15	8	430	28	8	490
16	8	440	38	8	510
17	8	450	60	8	530
18.5	8	460	96	8	550
20	8	470	200	8	560

The oils for tempering baths specified below are given for the sake of convenience only; the statements are based upon the findings of thorough experiments. There may, of course, be many other oils just as good that have not been tried.

(1) Walter A. Wood, Boston, Mass., XXX tempering oil; as cheap in initial expense as any; good lasting qualities.

(2) Frankfort tempering oil, Strong, Carlisle & Hammond Co., Cleveland, Ohio.

(3) Fish oil, cottonseed or linseed oil may also be used; in many cases these are mixed with high fire and flash test mineralized oils.

Tests and Analysis

The analysis and test results of oils when new (not used) as compared with those of oils which have been used such a

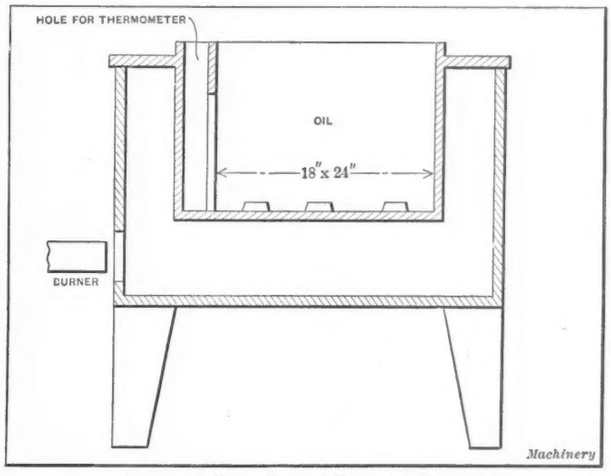

Fig. 9. Ordinary Type of Tempering Furnace

length of time as to render them practically valueless will be found interesting.

	W. A. Wood Tempering Oil		Lard and paraffine oil mixed (half and half) used for quenching	
	New	Old (thick)	New	Old (thick)
Flash point	550	475	400	380
Fire test	625	550	475	450
Mineral oil, per cent	94	30	25	10
Saponifiable oil, per cent	6	70	75	90
Specific gravity	0.920	0.950	0.912	0.925

Houghton tempering oil: flash point, 595 degrees; fire test, 685 degrees; specific gravity, 0.900.

Frankfort tempering oil: fire test, 670 degrees.

Frankfort quenching oil: fire test, 500 degrees.

Paraffine oil (Underhay): fire test, 450; specific gravity, 0.912.

Lard oil (Bleecker): fire test, ——; specific gravity, 0.920.

The great difference in tests and analysis between new and used oils should be noted; oils used constantly at high heats will gradually lose the "mineral" part of the oil, the more so the higher the heat used. A tempering bath can therefore be prolonged in life by adding to it now and then new mineral oil. To lengthen the life of the bath high heats should be avoided as much as possible.

Receptacles and Furnaces used in Quenching and Tempering

The main point to be considered in a quenching bath is, as mentioned, to keep it at a uniform temperature so that suc-

cessive pieces quenched will be subjected to the same heat. The next consideration is to keep the bath agitated, so that it will not be of different temperatures in different places; if thoroughly agitated and kept in motion, as is the case with the bath shown in Fig. 3, it is not even necessary to keep the pieces in motion in the bath, as steam will not be likely to form around the pieces quenched. Experience has proved that if a piece is held still in a thoroughly agitated bath, it will come out much straighter than if it has been moved around in an unagitated bath. This is an important consideration, especially when hardening long pieces. It is, besides, no easy matter to keep heavy and long pieces in motion unless it be done by mechanical means.

In Fig. 3 is shown a water or brine tank for quenching baths. Water is forced by a pump or other means through the supply pipe into the intermediate space between the outer and inner tank. From the intermediate space it is forced into the inner tank through holes as indicated. The water returns to the storage tank by overflowing from the inner tank into the outer one and then through the overflow pipe as indicated. In Fig. 4 is shown another water or brine tank of a more common type. In this case the water or brine is pumped from the storage tank and continuously returned to it. If the storage tank contains a large volume of water, there is no need of a special means for cooling. Otherwise, arrangements must be made for cooling the water after it has passed through the tank. The bath is agitated by the force with which the water is pumped into it. The holes at *A* are drilled on an angle, so as to throw the water toward the center of the tank. In Fig. 5 is shown an oil quenching tank in which water is circulated in an outer surrounding tank for keeping the oil bath cool. Air is forced into the oil bath to keep it agitated.

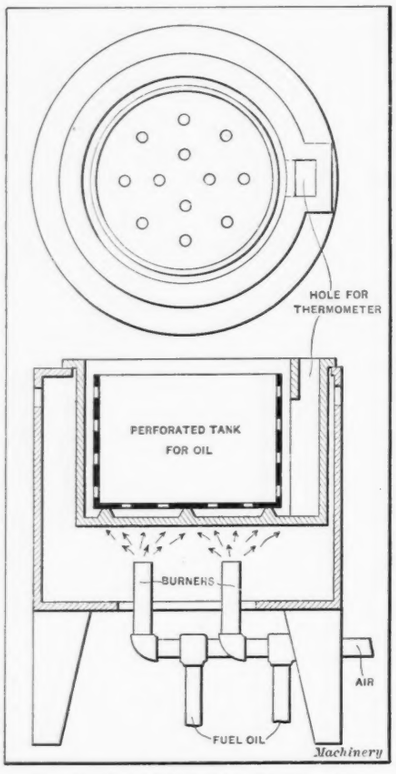

Fig. 10. Special Tempering Furnace with Perforated Oil Tank

Fig. 6 shows a water and oil tank combined. The oil is kept cool by a coil passing through it in which water is circulated, which later passes into the water tank. The water and oil bath in this case is not agitated.

Fig. 7 shows the ordinary type of quenching tank cooled by water forced through a coil of pipe. This can be used for either oil, water or brine. Fig. 8 shows a similar type of quenching tank, but with two coils of pipe. Water flows through one of these and steam through the other. By this means it is possible to keep the bath at a constant temperature.

Tempering Furnaces

In tempering furnaces the only really important consideration is to insure that the furnace is so built as to heat the bath uniformly throughout. It is doubtful if there can be found a tempering furnace on the market that will fill this requirement entirely, although many give good results in general. It is never safe, however, to let any tools being tempered rest against the bottom or sides of the tank, as no matter how scientifically the furnace may be built these parts are, in most cases, hotter than the fluid itself. It is, of course, just as important not to let the thermometer rest against any of these parts in order to insure correct readings. After the pieces tempered are taken out of the oil bath, they should immediately be dipped in a tank of caustic soda (not registering over 8 or 9), and after that in a tank of hot water. This will remove all oil which might adhere to the tools.

Fig. 9 shows an ordinary type of tempering furnace. In this the flame does not strike the walls of the tank directly. The tools to be tempered are laid in a basket which is immersed in the oil. In Fig. 10 is shown a tempering furnace in which means are provided for preventing the tools to be tempered from coming in contact with the walls or bottom of the furnace proper. The basket holding the tools is immersed in the inner perforated oil tank. This same arrangement can, of course, be applied to the furnace shown in Fig. 9.

* * *

ARE IRON AND STEEL CHIPS COMBUSTIBLE?

"Pig iron under water" has been described as a typically safe insurance risk, and to most persons iron or steel in any shape is equally free from liability to catch fire and burn up. Nevertheless, a recent experience of the Rushmore Dynamo Works in Plainfield, N. J., with a big pile of steel chips which actually caught fire from a blazing rubbish heap near by shows that finely divided iron or steel may sometimes oxidize faster than it can get rid of its heat, and hence may exhibit all the phenomena of combustion. The story is vouched for by Mr. S. W. Rushmore in the following words:

"Out in our yard we have a big heap of steel chips from the automatic turret and screw machines, which we sell from time to time in lots of several car loads. Steel being generally considered a non-combustible, this heap is quite close to the box lumber pile. Saturday afternoon, August 2, the pile stood eight feet high and contained several car loads, when the yard gang piled up alongside of it a lot of old barrels and rubbish and set fire to the latter. Of course, the steel pile got warm. On going my rounds, to see that everything was in shape before going home, I discovered smoke and flame issuing from the supposedly fireproof heap, which at several points at the bottom glowed white hot. The heat rapidly increased until it threatened to fire the lumber, so the watchman got out the hose and played a one-inch stream on the pile. The flame went down and I supposed the fire would soon go out, so I went home. Three hours later the night watchman 'phoned me that in spite of the hose the fire was getting worse, so I called the fire department, which found a lively little volcano at work. They worked on that pile of chips for just an hour with two powerful streams, and after many explosions of steam and gas, and after the whole yard had been flooded, declared the fire out and went home. At 10 o'clock Sunday morning the day watchman 'phoned me in a hurry that the fire had started again, and sure enough I found that darned pile a seething mass, making a weird and threatening hissing sound, but with little smoke and only thin yellowish flames. The department was again called, and after a couple of hours the pile was cooled down and dug into until apparently dead.

"The chips are put through a centrifugal separator, and the small amount of oil remaining had nothing to do with the fire. It was a plain case of burning iron. The metal was so finely divided, and presented so much surface to the oxygen in proportion to the radiating surface of the pile, that, once started by the heat from the rubbish pile, the combustion proceeded exactly as in a pile of coal, only apparently at a more rapid rate. I had never seen an iron fire before, and had never considered iron chips a fire risk, but anyone having seen that fire would never think of storing a large quantity inside any building. I was surprised to find that the metal had not melted. Where the fire had been hottest the chips were a dark blue. The pile sank about a third in height, and a lot of metal must have been oxidized to create so much heat. Next time I shall almost expect to see the concrete walls blaze up."

* * *

We talk lightly of high vacua, or even of a perfect vacuum, says the *Scientific American*. It is instructive to calculate the number of molecules contained in a cubic millimeter of gas at the lowest pressure on record. W. Gaede has recently succeeded in exhausting a vessel to a pressure of two ten-millionths of a millimeter of mercury (four one-thousand-millionths of a pound per square inch). At this pressure one cubic millimeter of gas would still contain about eight-and-a-half million molecules.

AN ITALIAN MILLING MACHINE

A MACHINE IN WHICH BOTH SPEED AND FEED CHANGES ARE DERIVED FROM THE SAME GEAR BOX

BY JOSEPH HORNER*

An unusual design of milling machine, manufactured by Officine Dubosc, Societa Anonima, machine tool builders of Turin, Italy, is shown in Fig. 1. The most interesting feature

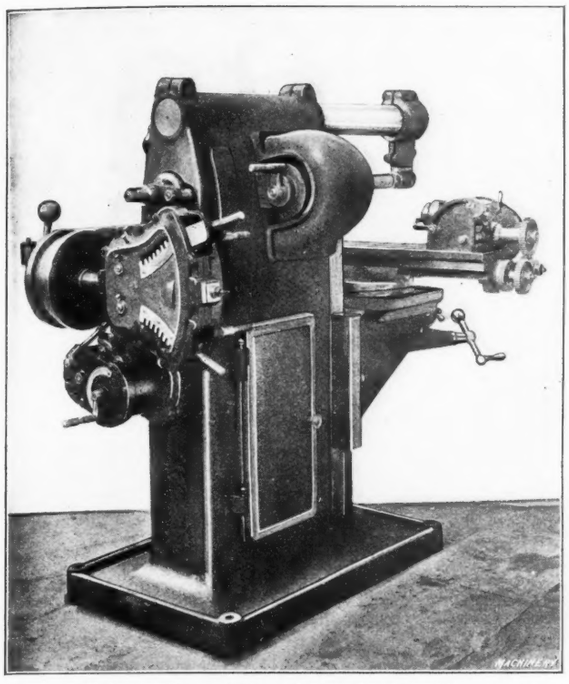

Fig. 1. Italian Milling Machine with Combined Speed- and Feed-changing Mechanism

of this machine is the mechanism by means of which the speed and feed changes are obtained. The power is derived from a single belt pulley which transmits motion through a cluster of bevel gears enclosed in a box at the rear of the column. The main spindle is driven through a sliding gear meshing with one side of the central cone of gears, and the feed mechanism is driven through a sliding gear on the opposite side of the central cone.

Fig. 2 is a rear elevation showing the outside of the gear box, and Fig. 3 is a sectional view showing the nest of cone gears and their relation to the driving pulley. This pulley *A* is driven at 320 revolutions per minute. Normally, it runs loosely on the hubs of friction disks *D* and D_1 and is provided with a brass bushing. The belt pulley is engaged or disengaged by means of these friction disks which are located on each side, as shown. The disks are operated by a lever attached to part *B*, the lever being weighted with a knobbed handle, as shown in Fig. 1. When the machine is not in use, the friction disks are kept out of contact with the pulley by a coiled spring located in recesses formed at the inner ends of the disk hubs. Part *B* has a threaded extension which screws into a bushing in bearing bracket *C*. When the ball-handle attached to *B* is turned to the right, the adjustable screw *E* and part *B* move axially and cause disk *D* to grip the driving pulley. The amount of this axial movement is slight, being just enough to make and break frictional contact with the pulley.

The pulley shaft *G* is mounted in three bearings and is equipped with a ball end-thrust bearing, having provision for adjustment by means of lock-nuts. On the right end of this shaft, through which power is transmitted to the spindle and feeding mechanism, a cone of seven bevel gears is keyed permanently. The sliding gears *H* and *F*, which are feather-keyed on the diagonal shafts seen above and below, can be engaged with any one of the cone of gears on shaft *G*. The speed changes are obtained by shifting lever *N* and gear *H*, and the feed changes by lever *O* and gear *F*. These levers have two movements; that is, they swing vertically about pivots at the inner ends, to bring the sliding gears into mesh with large or small gears of the cone, and the handles and sliding gears also have an axial movement. As will be seen, the gears are carried in bosses at the ends of the handles, in which they are secured by circular nuts. The axial movement is provided for by splines extending along the pivoted shafts.

In the diagram Fig. 4, the locations of the centers of the pitch cones for different positions of the movable gears are shown by the small circles. The apices of the pitch cones of any movable and fixed gear that may be in mesh intersect on the center line of the central cone of gears. The speed- and feed-change levers are properly located and locked in each position by a series of notches with which suitable locking pins engage. Adjacent to each notch the speeds and feeds which correspond to that particular position are stamped.

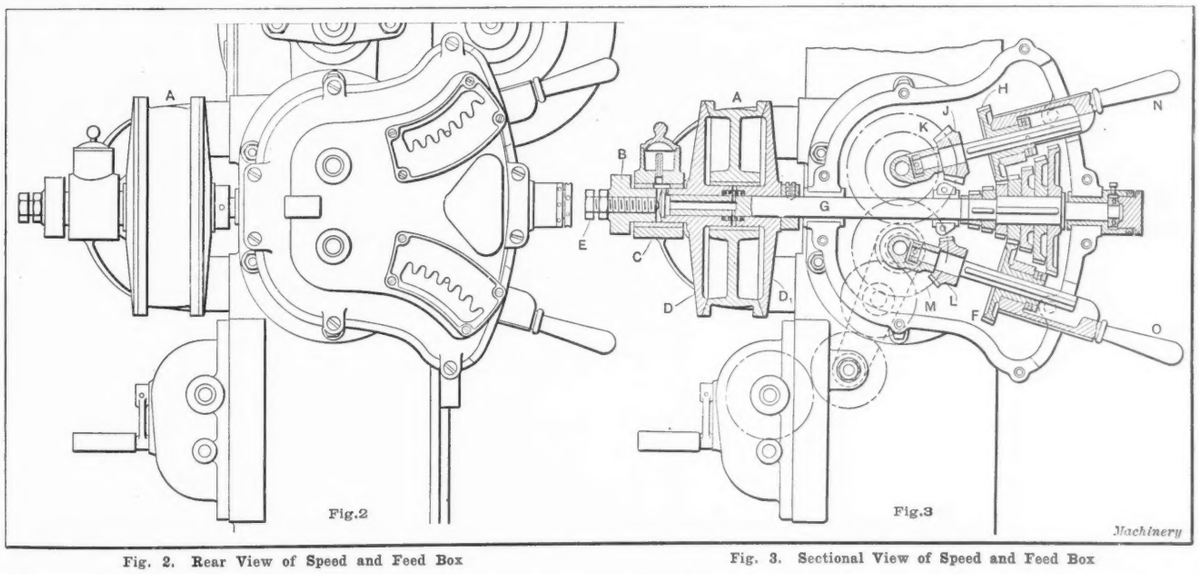

Fig. 2. Rear View of Speed and Feed Box

Fig. 3. Sectional View of Speed and Feed Box

The speed and feed motions are transmitted through the sliding bevel gears *H* and *F* upward and downward, respectively. Motion to the spindle is transmitted through fixed pinion *J*, which engages with gear *K* (see Figs. 3 and 5). Gear *K*, in turn, is keyed to a horizontal shaft *N*, Fig. 5, having at its opposite end a gear *O*. The latter is constantly

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in mesh with gear *P*, which, with gear *S*, runs loosely on the main spindle *Q* of the headstock. On this spindle a larger gear *R* is keyed. By means of these gears, and the spring pins *B*, the spindle can be driven either direct or through the back-gearing. This change is effected by operating a forked lever engaging with collar *T* and actuated by the handle seen at the rear of the housing, in Fig. 1. When the spindle is driven direct, gears *P* and *R* are locked together by pins *B*, at which time the back-gears are disengaged. The movement of the lever for shifting collar *T* also controls the position of the back-gears, so that when the spindle is to be driven direct the back-gears are automatically disengaged.

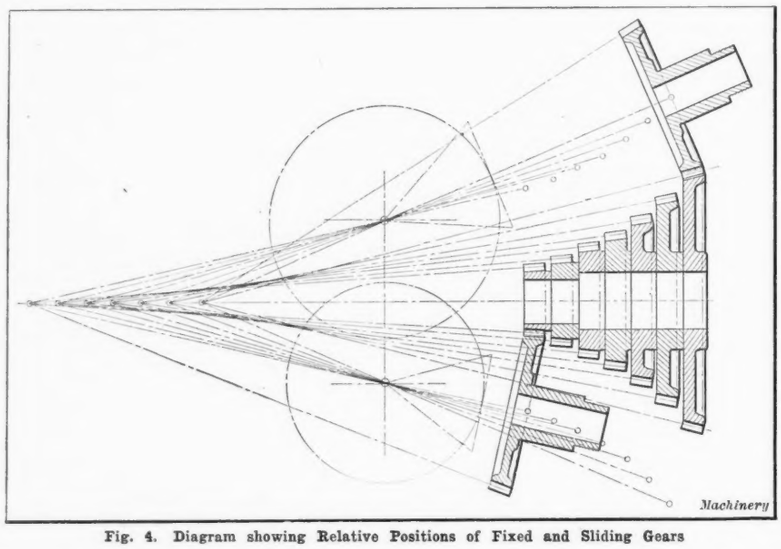


Fig. 4. Diagram showing Relative Positions of Fixed and Sliding Gears

The speed-changing mechanism gives the following revolutions of the cutter spindle per minute:

With the back-gears in mesh....	14	17	22	27	34	42	54
When driving direct.....	63	84	108	132	164	203	260

The feed motion is derived from fixed pinion *L* which meshes with gear *M* (Figs. 3 and 5). The latter is keyed to shaft *W*, which, through gears *X*, transmits motion to feed box *Y* at the rear of the machine. At this point two changes of feed can be obtained by shifting the handle seen attached to the box in Fig. 1. The feeding movement is transmitted to the front of the machine through a telescopic shaft in the usual manner. Gear *Z*, through a shaft and gear meshing with gear *A*, drives the cross-feed shaft which engages nut *C*. This nut has an adjustable section for taking up the back-lash due to wear of the threads. The shaft driven by gear *Z* carries the miter gear *D* which meshes with another miter gear on the vertical shaft (not shown) from which pinion *E* is driven. The latter, in turn, transmits motion to miter gear *F*, which actuates the longitudinal feed-screw; the latter is provided with the usual reverse clutch. The vertical adjustments of the knee are effected by a ball-handle having a shaft set diagonally and connecting with the telescopic screw through a pinion meshing with bevel gear *J*. The main spindle bearings are fitted with split boxes which are fitted in bored conical seats. Axial adjustment is provided for taking up wear.

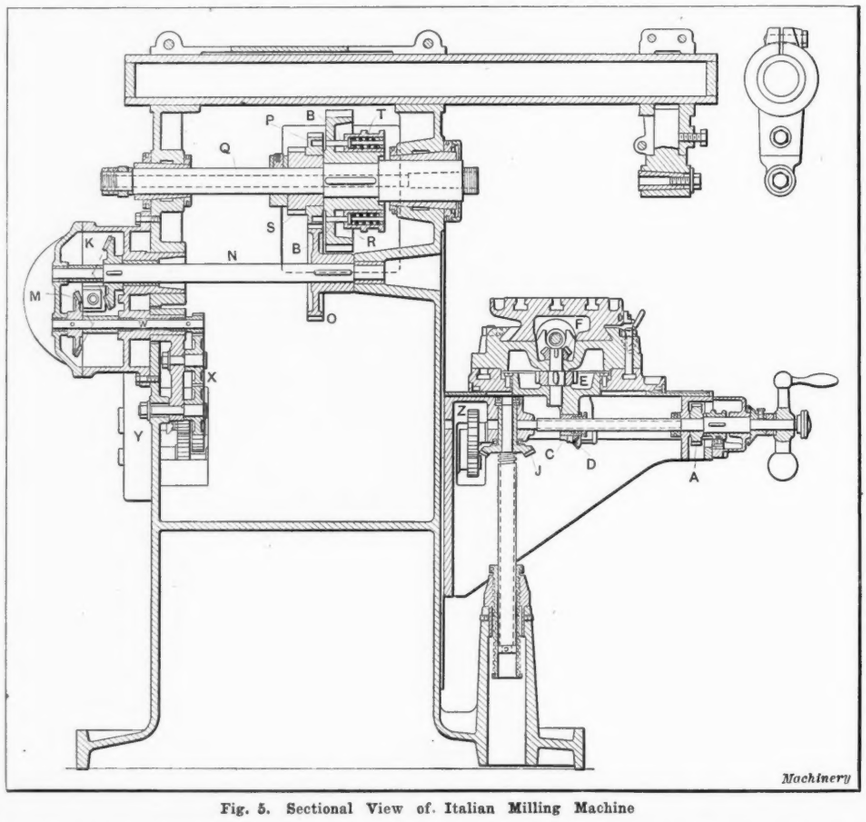


Fig. 5. Sectional View of Italian Milling Machine

REDUCING SHOP COSTS

The efficiency expert or systematizer who tries to accomplish a reduction of manufacturing costs by reducing wages is attacking the problem at the wrong end, and he generally comes to speedy grief. The storekeeper who tries to get more trade by reducing prices is in the same class. The storekeeper is likely to go into bankruptcy soon after having demoralized his trade and prices. Both the efficiency expert and the storekeeper fail to realize that the secret of success is service. The systematizer's real business is to train the employes to produce more with the same effort and thus to earn more for themselves and the concern employing them. To cause them to earn less for themselves will almost inevitably result in earning less for their employers. The storekeeper who cuts prices voluntarily reduces his own wages, which means that he must eventually render poorer service. What he should do is to study how he can serve the public better. If he can render better service and thus attract larger trade at standard prices, he may then be able to reduce prices because he is producing more per employe, and all are earning more. Service should be the motto—not merely reduction of costs. More service means lower costs, and this applies to goods and wages alike.

* * *

CYANIDE FOR CLEANING HARDENED STEEL

A method of treating taps and other tools in hardening which leaves them free from scale and with a silvery surface is to use a layer of potassium cyanide on top of a lead heating bath. A tap or other tool immersed in the lead receives a coating of cyanide which cleans off all scale or rather prevents its formation. When dipped in the hardening bath the cyanide dissolves instantly, leaving the work in condition for rapid polishing. Of course an exhaust hood must be provided over the pot to draw off the deadly cyanide fumes.

RESISTANCE OF STEELS TO WEAR IN RELATION TO HARDNESS AND STRENGTH*

The increasing speeds and heavy duty of machinery and motive power, with resultant shortening of the length of service of parts through rapid wear, makes the study of wear resisting qualities of metals, especially steel, one of increasing importance. In the railway field, the increasing wear of tires and rails due to increased loads and speeds is a serious matter. Not only is it desirable to have high resistance to wear, but it is necessary to have other qualifications, such as strength and toughness, to insure against failure or breakage. The tests described in this article were undertaken with the object of studying the relations, if any, between the wear resistance of various steels and the various physical properties of elastic limit, tensile strength, and hardness. Owing to several protracted interruptions, only a relatively small proportion of these tests have so far been completed.

There are three classes of wear: (1) Abrasion—such as grinding, crushing and excavating machinery is subjected to. (2) Lubricated sliding or rolling friction, such as that experienced by machine parts, axles and shafting. (3) Dry rolling friction of the kind existing between wheels and rails. The first class, wear by abrasion, is in many ways less important than the other two. It has, however, been utilized frequently as a means of comparing the wearing qualities of metals for all three classes. The machines used for this purpose are some form of grinding machines and the specimens are ground or abraded under a constant pressure for a certain length of time. The amount of metal removed under these conditions determines the relative wearing value. The most extensive investigations along this line were made by F. Robin and published in the 1910 proceedings of the British Iron and Steel Institute.

Investigations of wear by lubricated friction have been in the past largely confined to bearing metals rather than steel. This undoubtedly has been due to the fact that steel is usually worked against soft bearing metals or bronzes which wear much faster. The investigation of the wear resistance of steel and iron under lubricated friction, however, is growing more important with the increasing severity of the requirements of service. Probably the most satisfactory machine for testing wear under lubricated sliding friction is the Derihon machine consisting of a hard steel disk revolving in oil, against the edge of which is pressed the test specimen. E. Nusbaumer, engineer of the Derihon Steel Works, describes this machine and some tests made with it in the proceedings of the fifth congress of the International Association for Testing Materials, 1909.

The third class, wear by dry rolling friction, is the most important; especially when we consider the vast tonnage of steel in service in the form of rails, wheels and tires. A machine for investigating wear under dry rolling friction was described by E. H. Saniter in 1908—British Iron and Steel Institute—and consists essentially of a revolving test specimen which drives by friction the inner ring of a ball bearing, the outer ring of which is stationary and loaded. At the sixth congress of the International Association for Testing Materials, Mr. Saniter presented a report on hardness testing and resistance to mechanical wear and gave a summary of the results obtained by Robin, Nusbaumer and himself of the investigation of each of the three classes of wear. The general conclusions of Mr. Saniter were "that while metal with a high Brinell number may be expected to give better wear, there are so many exceptions that the use of a hardness test for the purpose of indicating wearing properties is unreliable as far as the methods of wear testing reviewed are concerned."

The investigations of the author have been confined so far to the third class of wear *i. e.*, dry rolling friction. The machine used is a modification of Dr. Stanton's fatigue-testing machine described by him in a paper before the British Iron and Steel Institute, 1908. Details of the machine are shown in the illustration. It consists essentially of three casehardened rollers 3½ inches in diameter. The two lower rollers are driven by gears, while the third or upper roller is driven by friction. The upper roller is carried in the lever by which the load is applied to the test specimen. A load of 1000 pounds on the specimen is possible with this machine. The rollers each have a groove in the middle, ¼ inch wide, to take the corresponding band on the test specimen and keep it from lateral motion. If the rollers all revolved at a uniform speed the amount of wear on the test specimen would be very slight, practically nil, as there would be no slippage of the test specimen. In order to accelerate the wear and approximate as nearly as possible the actual wearing conditions of wheels and rails, the two lower

TABLE I. CHEMICAL COMPOSITION OF STEELS TESTED

Mark	Wear Mg. per 1,000,000 Rev.	Treatment, Degrees C	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Chromium, Per Cent	Nickel, Per Cent	Vanadium, Per Cent	Remarks
P	3813.2	none	0 25	0.60	....	....	....	....	
P-1	2436.4	825—600	0.25	0.60	....	....	....	....	
O	1462.0	none	0.45	0.48	....	....	....	....	
O-1	1334.8	825—600	0.45	0.48	....	....	....	....	
8	1120.5	none	0.66	0.70	0.27	....	....	....	Tire
M-1	1104.1	825—600	0.28	0.61	0.28	....	3.10	....	
12	1079.6	825—600	0.75	0.68	0.25	....	....	....	Tire
E-1	1043.1	825—600	0.43	1.30	....	....	....	....	
U-1	958.0	825—650	0.58	0.65	0.20	1.26	....	0.20	Tire
C-1	829.8	825—600	0.38	0.30	....	1.16	2.08	....	
K-1	436.8	900—600	0.46	0.90	0.11	1.03	....	0.14	
F-1	371.9	825—600	0.48	1.15	....	....	....	0.22	
22	368.8	900—625	0.62	0 62	0.27	0.95	....	0.24	Tire
Y-1	367.8	900—600	0.28	0.50	0.12	0.96	....	0.22	
J-1	261.0	900—600	0.46	0.86	0.06	1.02	....	0.22	
D-1	230.1	825—600	0.42	0.22	....	1.27	2.14	0.26	

Machinery

Note—Under the heading Treatment, 825—600 degrees C, for example, indicates that the specimen was oil-quenched from 825 degrees and drawn back at 600 degrees C.

TABLE II. RELATION BETWEEN HARDNESS, TENSILE PROPERTIES AND WEAR

Mark	Wear, Mg. per 1,000,000 Rev.	Hardness		Elastic Limit, Pounds per Square Inch	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent in 2 Inches	Reduction of Area, Per Cent	Treatment, Degrees C
		Brinell	Scleroscope					
P	3813.2	134	23	47,000	68,000	33.0	57.3	none
P-1	2436.4	170	27	58,000	80,000	28.5	67.0	825—600
O	1462.0	156	26	43,000	79,000	28.5	47.5	none
O-1	1334.8	207	30	71,000	96,000	23.0	57.3	825—600
8	1120.5	196	34	63,000	121,000	14.0	19.0	none
M-1	1104.1	207	30	87,000	100,000	25.0	67.5	825—600
12	1079.6	228	38	97,560	144,930	15.0	23.0	825—600
E-1	1043.1	223	35	91,000	105,000	23.5	58.6	825—600
U-1	958.0	248	43	98,000	120,000	19.0	52.8	825—650
C-1	829.8	286	47	127,000	134,000	20.0	57.3	825—600
K-1	436.8	340	54	156,000	163,000	15.0	45.0	900—600
F-1	371.9	262	42	115,000	127,500	18.5	54.7	825—600
22	368.8	302	43	128,000	147,000	16.5	42.0	900—625
Y-1	367.8	293	50	137,000	148,000	16.5	46.0	900—600
J-1	261.0	340	54	162,000	167,500	14.5	49.0	900—600
D-1	230.1	340	52	156,000	161,150	16.0	53.3	825—600

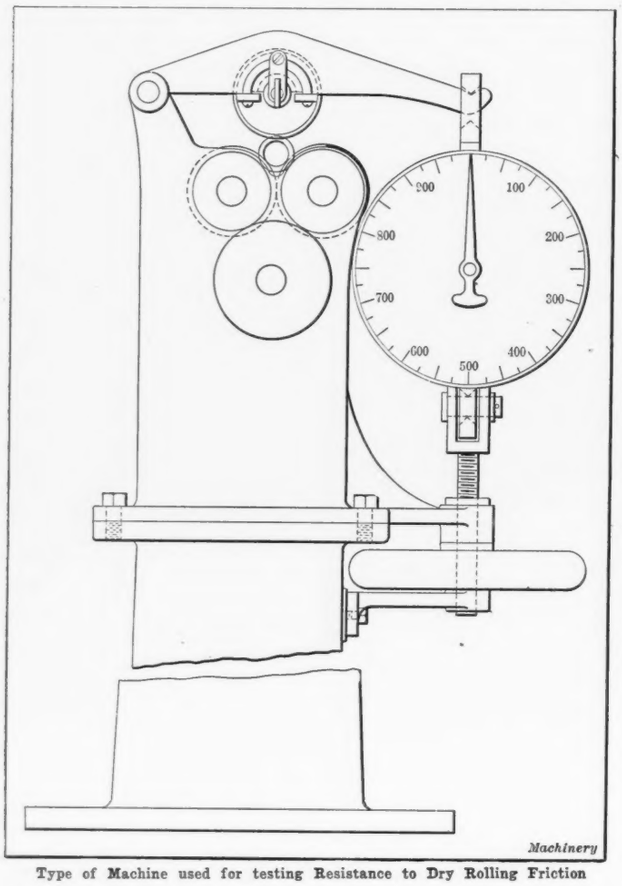
Machinery

*Abstract of a paper read by George L. Norris before the sixteenth annual meeting of the American Society for Testing Materials.

rollers are driven at different speeds to produce slippage of the specimen. This is accomplished by having three less teeth in one of the driving gears.

The test specimens are 2 inches long by ⅞ inch in diameter; and the guide band is ⅛ inch larger in diameter and a scant ¼ inch wide. They weigh about 160 grams and can be accurately weighed on a chemical balance to 1/10 milligram. The diameter of the specimens which this machine will accommodate can vary from ⅝ inch to 1½ inch as may be required. The driving speed of the machine is 1000 revolutions per minute, and the speed of the test specimen is about 5000 revolutions per minute. The usual run before weighing is 100,000 revolutions of one of the driving rollers, corresponding to practically 500,000 revolutions of the test piece. In the following tests the applied load was 224 pounds, or 100 kilograms. Excepting in the cases noted in Table I, the specimens were all turned from rolled bars 1⅛ inch in diameter. While the tests show a general decrease in the amount of wear, as the hardness and strength increase, the progression is very irregular, and there are several instances where softer steels show less wear than the harder ones, as, for example, 12 and E-1; C-1 and F-1.

It is evident that the composition of the steel influences the resistance to wear to a very considerable degree. Robin,



Type of Machine used for testing Resistance to Dry Rolling Friction

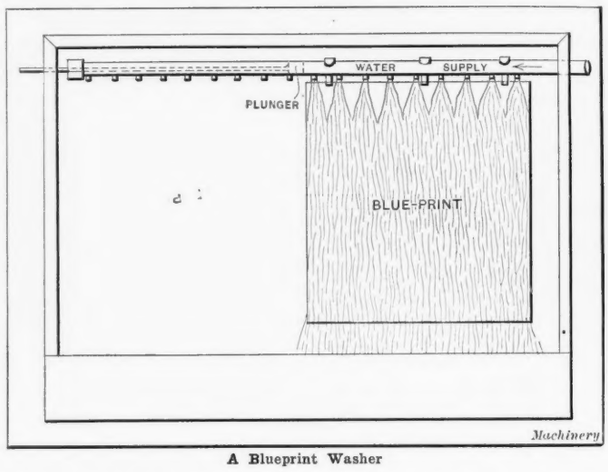
in his investigations, found that nickel, chromium and vanadium each increased the resistance of the steel to wear. The tests made by Nusbaumer showed remarkable resistance to wear in low carbon steel with manganese about 1.5 per cent. Saniter, on the contrary, did not find increased resistance to wear in the case of the few alloy steels he reported, excepting for a high manganese steel of the Hadfield type. His chrome-vanadium anad nickel-chrome steels gave greater wear with greater hardness than simple carbon steels of about 0.70 per cent carbon and 0.60 per cent manganese.

The tests made by the writer confirm the conclusions of both Robin and Nusbaumer, and also those of actual experience that manganese, nickel, chromium and vanadium have a marked effect on the wearing quality of steels. Manganese apparently has a greater effect than either nickel or chromium. Vanadium, however, evidently has a much greater effect than either of these three elements, as it only requires a very small percentage to produce a marked increase in resistance to wear. This is very apparent in steels E-1 and F-1, and C-1 and D-1, each of which pairs is practically alike, excepting for vanadium. As stated in the beginning of this article, these tests are only a small proportion of those planned, and it is the intention to cover not only a considerable range in composition and heat-treatment, but also to study the effect of rollers of different composition and hardness on the rate of wear of the various steels.

* * *

A BLUEPRINT WASHER

A little kink in washing blueprints that is in use in the drafting-room of the George P. Clark Co., Windsor Locks, Conn., seems worthy of description. The principal feature of this washing arrangement is that it takes care of small prints as well as large ones without waste of water. Above the washing sink there is an upright board, slightly inclined, along the top of which runs the water supply pipe, as shown in the accompanying illustration. The blueprint is hung over the top of this pipe by means of clips and the water emerges from small openings closely spaced in the bottom of the pipe. Within the supply pipe there is a plunger which may be moved to any desired position by means of a rod which extends through the blind end of the pipe. This plunger serves to cut off the water supply at any desired point, and limits the stream to passing through the openings at the right of the



A Blueprint Washer

plunger, bringing the full force of the water upon the print and nowhere else. Thus, when a small print is being washed, it is hung at the right-hand side of the washing tank and the plunger moved, so as to limit the progress of the water to the section of the tank occupied by the blueprint. This prevents waste of water and confines that in use to the space occupied by the blueprint, resulting in quicker and better washing.

C. L. L.

* * *

The press agent of the New York, New Haven & Hartford Railroad has great faith in the new steel passenger cars. In describing the Merchants' Limited Express train, "the most gorgeous train in America," he says: "These new trains are practically indestructible. Made of steel, they could go through a stone wall without being scratched. Reinforced underneath with two immense steel girders running the length of the car and attached at the end to a solid cast-steel U-frame, forming the vestibule, no impact, however great, could telescope them. A rear end collision might tilt them up on end a bit, but that would be all. So far as resisting powers go they are built like battleships."

* * *

Speed at the expense of quality is easy, because it is sliding down hill.

ELECTRIC FURNACE HEAT-TREATMENT OF STEEL*

ARRANGEMENT OF THE ELECTRIC FURNACE—EFFECT OF DIFFERENT ELEMENTS ABSORBED BY HEATED STEEL

BY E. F. LAKE†

The use of electric furnaces for hardening and tempering steel, has passed through the experimental stage and there are several types now on the market that have been made commercial successes. It is now about three years since the electric furnace was placed on the market that uses a molten salt bath in which to heat the steel to any of the hardening temperatures used for carbon, alloyed or high-speed steels. This electric salt-bath furnace is also used for any drawing temperature above the flash points of oil, while an oil bath type is used to heat steel to drawing temperatures below this flash point. In the salt-bath furnaces, the electric current is sent directly through the salt by placing electrodes inside of the bath on opposite sides, while in the oil bath furnaces the oil tank is heated from the outside.

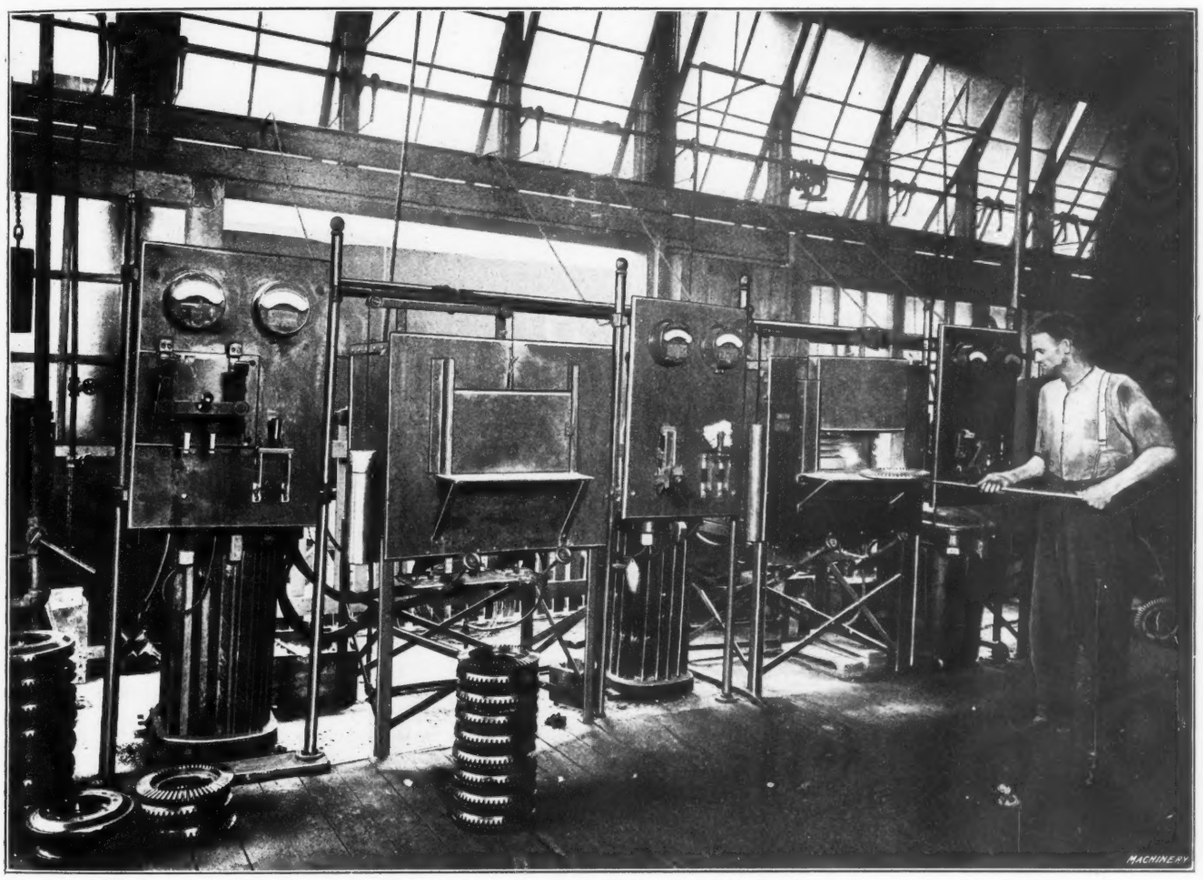


Fig. 1. Battery of Hoskins Electric Hardening Furnaces

Since the introduction of the salt-bath furnace, the oven type of electric furnace has been perfected and installed by several manufacturers for commercial work. Small furnaces of this type have long been in use for laboratory and experimental work, but the principle used for heating, namely, sending the current through coiled resistance wires inside of the heating chamber, is too expensive for the larger furnaces used for commercial work, and the high temperatures required for high-speed steel cannot be reached without burning out the resistance wires. They are very successful, however, for small furnaces that are used at temperatures below 1800 degrees F.

One of the largest installations of this kind is the battery of electric hardening furnaces that are in daily use at the Timken-Detroit Axle Co's. plant, as shown in Fig. 1. These were manufactured and installed by the Hoskins Mfg. Co. of Detroit, Mich. Each separate unit consists of a furnace, switchboard and transformer, which stands back of the switchboard. On the board is placed the line switch for turning on and off the current; a circuit breaker, adjusted to open the circuit automatically in case of an excessive flow of current; an ammeter to show the amount of current being used; and a pyrometer to indicate the temperature inside of the furnace. No rheostat is required, as the furnace can be adjusted to regulate the amount of current that is necessary to produce any given degree of temperature.

Heating Gears in Electric Furnace

The bulk of the work heated in these furnaces consists of the gears that enter into the construction of rear axles used on automobiles. In Fig. 2 is shown the method employed to heat the driving gears to the hardening temperature. It was difficult to harden these large ring gears uniformly at accurate predetermined temperatures, without warpage, before the electric furnaces were installed, but now most of the difficulties have been overcome and good results are obtained. The gears are first preheated to about 1200 degrees F. in another kind of furnace, the corner of which is shown to the right in the halftone. Four gears are then placed on the thick iron disk *A* and heated to the correct temperature for quenching to harden. The disk *A* is slowly revolved automatically, by mechanical means, to insure obtaining a uniform temperature around the entire circumference of the gears. To re-heat four carbon-steel gears, 11¼ inches in diameter, from the 1200 degrees of the preheating furnace, to the 1500 degrees required to harden the gears, takes about twenty minutes. Prolonged heating does not harm the gears as the furnace is maintained at the correct hardening temperature and they will not be overheated, while the atmo-

* For additional information on electric furnaces see the following articles previously published in MACHINERY: "Improvements in Electric Furnaces," July, 1912; "Heat-Treatment of Steel by the Electric Furnace," June, 1912; "Electric Hardening Furnaces," December, 1908; "Hardening Steel by Electricity," February, 1907.

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sphere is reducing and thus prevents the formation of any scale. If not left in long enough, however, they will not attain the temperature of the furnace and therefore the quenching will not give them the desired hardness.

Adjustment and Arrangement of the Electric Furnace

To keep the furnace at the desired temperature, handwheels *B* are turned either to the right or left. This either raises or lowers the electrodes and squeezes together or allows gaps between the carbon plates that form the sides of the interior walls of the furnace. The carbon plates on one side can be seen at *C*. Squeezing the carbon plates together, causes more current to flow and hence more heat to be generated, while allowing them to separate, reduces the flow of current and also the heat inside the furnace. By watching the ammeter, any desired temperature can be produced when one knows what ammeter reading corresponds to this temperature. The operation can be more plainly seen by referring to Fig. 3, which is a sectional view through the center of the furnace. *J* is the heating chamber and *I* the outer shell, which is filled with firebrick. The screws *G* are operated by handwheels *B* to raise and lower electrodes *F*. The latter, in turn, press against graphite blocks *E*, to squeeze together or allow gaps to occur between the carbon plates *C* that form two sides of the interior of the furnace. *D* is the carbon top plate, or roof, and *H* the cement bottom of the heating chamber. The current enters and leaves the furnace at *K*.

Action of Carbon in Heated Steel

It is a well known fact that steels absorb various elements which they come in contact with, when the conditions are conducive. As is well known, this is the principle of the

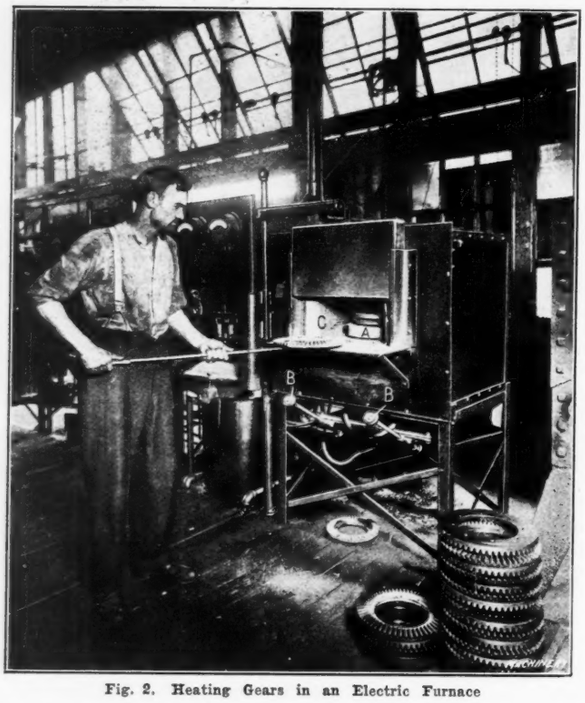


Fig. 2. Heating Gears in an Electric Furnace

carbonizing process. Many impurities which injure some of the good qualities possessed by the metal, are absorbed under certain conditions, and several elements that better some qualities are absorbed under other conditions. Some of these conditions are known and can be controlled, while many others are unknown or partially known.

Some beneficial elements, of which chromium is an example, can be injected into steel. Carbon flows through steel in a somewhat similar manner to the flow of electricity, although very much slower. If a piece of high-carbon steel and a piece of low-carbon steel are bound closely together and allowed to stand a long enough time, they will both have the same percentage of carbon. This would take many years at atmospheric temperatures, but if the steel is heated, each degree of temperature increase accelerates the flow of the carbon. When the molten stage is reached, minutes will produce, in the equalization of the carbon content, what it might take centuries to produce at atmospheric temperatures.

The principle here involved is that carbon flows to the body or element which has the greatest attraction for carbon. In carbonizing steel, a carbonaceous gas is produced, but the steel has a greater attraction for the carbon than the atmosphere in the carbonizing retort and hence it enters into a combination with the steel. Likewise, with two pieces of steel, the one low in carbon has a greater attraction than the piece high in carbon and draws this element away until the attractive force in each piece has been equalized. In manufacturing steel, the carbon is put into the molten metal and as the iron has a greater affinity for carbon than any of the elements in the slag, it combines with the iron and stays in the steel thus produced; hence, the correct percentage is found in the finished product.

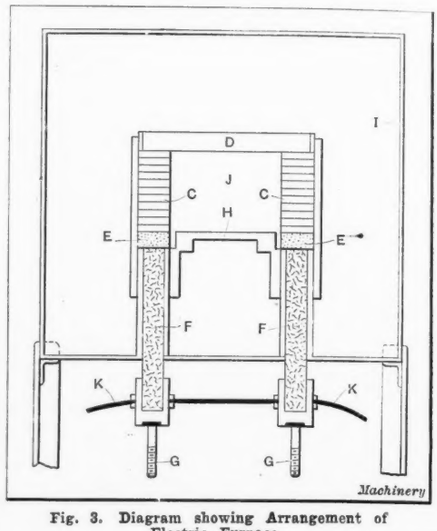


Fig. 3. Diagram showing Arrangement of Electric Furnace

In some furnaces, we often find decarbonized spots in steel that has been heated for hardening. A condition has here been produced whereby some element has entered the heating chamber that has a greater attraction than iron for the carbon; hence enough carbon flowed out of the steel to satisfy this attraction for the time this condition prevailed. Time and temperature seem to be the two factors that control the rate of flow of the carbon. Salt and lead-bath furnaces may produce these decarbonized spots. Sometimes a pitting of the surface occurs, which means that some element is present that has a great attraction for iron and has eaten it away.

In the electric furnaces previously referred to, no such elements seem to be present, as pitted and decarbonized surfaces are not found in the steels heat-treated in them. This applies to the carbon steels, which are heated to hardening temperatures as low as 1300 degrees F., and also to the high-speed steels that require a temperature as high as 2200 or 2300 degrees. Nearly all of the temperatures between these points are utilized, as the correct hardening temperature for some of the carbon steels is as high as 1500 degrees, while the alloyed steels require from 1500 to 1700 degrees and some high-speed steels need a temperature as low as 1750 degrees. The elimination of pitting and decarbonizing is doubtless due to the fact that the oxygen in the air is not required to perfect combustion and none of the products of combustion are present to attack the metal. As the steel leaves the furnace, no scale can be seen and scale always comes from an excess of oxygen. Even when the heated steel is held in the air, the formation of scale starts very slowly; neither is there any of the deposit that is sometimes produced by the products of combustion.

Effect of Oxygen on Iron and Steel

Under certain conditions oxygen has a great affinity for iron and penetrates steel much more rapidly in a moist atmosphere, or one that has been heated. If steel is left in a damp place, it is only a question of time when it will be reduced to an iron oxide in a powdered form, the degree of dampness being the factor that governs the speed of this reduction. This is due to the fact that oxygen forms only one-fifth of the air, whereas it forms eight-ninths of water, by weight.

Thus, if steel is immersed in water it decomposes much more rapidly than when left in the air. Salt water reduces the time of this decomposition as the salt aids the oxygen in forming its combination with iron. Without the aid of moisture, any increase in the temperature of steel increases the ability of oxygen to unite with the iron. When the boiling point is reached, the metal is saturated with oxygen and other gases, but the bulk of these are expelled when the steel solidifies. Enough is often left, however, to considerably weaken its various physical properties.

In furnaces that depend on combustion, or flames, for obtaining the necessary heat, a scale is liable to form on steel at the temperatures required for hardening, unless all of the oxygen is utilized to form the combustion and passes out of the vent as carbon dioxide (CO_2). This scale injures the piece being hardened, as it reduces its size and makes the surface uneven. This formation of scale proves that oxygen combines with steel at temperatures way below the melting point; hence the valves of such furnaces must be carefully adjusted so as not to deliver an excessive supply of air.

In addition to the formation of scale, oxygen injures steel in other ways. When the steel is heated to the higher temperatures, oxygen may enter the open pores to form microscopic bubbles and thus reduce the cohesive force that binds the molecules of the mass together. It may take the form of occluded gas in combination with other gases, or it may form a ferrous oxide with the iron. In any of these forms, oxygen reduces the strength, wearing qualities and resistance to fatigue or torsion stresses. Steels containing oxides also rust more quickly than those that are practically free from them. It is not so much the oxygen itself that is injurious, as it is the oxides that it forms with other elements. The percentage of oxygen has heretofore been considered to be too small to be taken into account, but it is now known that 0.05 per cent of oxygen is equal to 0.22 per cent of ferrous oxides and this is sufficient to materially reduce the physical properties. As oxygen is a gas, it was long difficult to analyze steels for this element, but with the new methods that have been devised, it has been found to be present in steel in larger quantities than was supposed, and efforts are now being made to reduce this impurity in all steels. That the pores of steel are opened by heat and allow the gases to enter or leave, has been proved by a number of experiments where both cast and rolled steel have been heated in a vacuum. Under this condition, the gases began to leave the steel at temperatures between 300 and 600 degrees F. The volume reached a maximum at temperatures between 900 and 1000 degrees, and then reduced to a minimum volume at about 1300 degrees. Another maximum point was reached at about 1450 degrees; then again reduced and again increased at higher temperatures. The greatest evolution of gas seemed to take place at the transformation point of the metal. That gases travel into the steel under atmospheric pressure, instead of out when in the vacuum, is shown by the fact that oxygen combines with iron and raises blisters or scale and also that nitrogen penetrates steel that has been raised to temperatures around 2200 degrees.

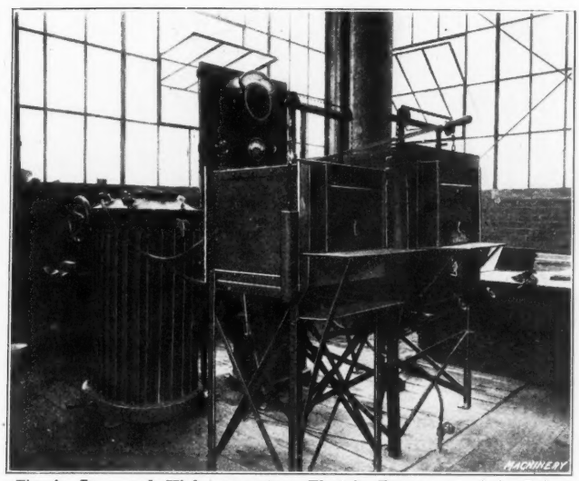


Fig. 4. Low- and High-temperature Electric Furnaces used in Pairs

Effect of Nitrogen on Steel

Nitrogen is just beginning to be recognized as an injurious element in steel. It now occupies practically the same position that sulphur and phosphorus did but a short time ago, when the chemist first proved that they were very injurious elements to the physical properties and means should be devised to keep them as low as possible. Then the practical steel makers scoffed at the chemists for saying that such small percentages of any element could weaken the steel and if it did their ancestors would have made it known. One does not have to be very old to remember the time when such talk was prevalent in the steel mills. It has been proved, however, that nitrogen is as liable to cause brittleness and "cold shortness" as does phosphorus and is as injurious.

The better grades of steel contain 0.005 to 0.025 per cent of nitrogen, while the cheaper grades contain between 0.010 and 0.065 per cent. Each increase in the percentage causes the elongation to diminish rapidly and the ductility to reduce. At first, only a slight decrease occurs in the toughness, but the decrease becomes more rapid as the percentage of nitrogen increases. When the carbon content of steel is high, 0.035 per cent of nitrogen will cause the elongation and contraction to become practically nil, while in medium carbon steel it may take a nitrogen content of 0.050 per cent to accomplish this, and 0.065 per cent in low-carbon steels. Steels made in the resistance type of electric furnace contain only traces of nitrogen, but those made in the presence of basic slag in the arc type may contain an injurious amount.

As four-fifths of the air is composed of nitrogen, by volume, consuming the oxygen with a flame would leave much of the nitrogen free to enter the pores of steel that is heated to the hardening temperatures in ordinary oven furnaces; especially when the steel is heated to the 2200, or more, degrees F. required for hardening some brands of high-speed steel. Decarbonization is doubtless due to the nitrogen that may be occluded in steel combining with the carbon to form methane, which escapes when the metal is heated. Hydrogen being the lightest of the gases, if any of this is present in the steel, it will escape when the metal is heated. This will cause the proportion of nitrogen to carbon to increase and thus enhance the tendency toward decarbonization. As the resistance type of electric furnaces do not consume any of the oxygen in the air, none of the nitrogen is set free. Thus a condition that allows the nitrogen to penetrate the steel is not created, even though it be heated and the pores open. As steel pieces do not warp as much in this type of electric furnaces, as in coal-, oil-, or gas-fired furnaces, it may be because the metal is more dense owing to its not absorbing any gases. The absorption of nitrogen, followed by the formation of iron nitrides, keeps molecules of their own kind further apart by preventing the iron molecules and iron-carbide molecules from coalescing. This causes a greater contraction of the metal, and, consequently, a lower temperature, before the like molecules are brought sufficiently near together for the molecular attractive force to effect a change; hence there is a greater tendency for the piece to warp.

The combustion type of furnace, especially when using coal as fuel, gives off many elements as products of combustion which may be injurious to steel. Among these may be mentioned such hydrocarbons as anthracine, naphthalene, toluene, benzine, methane, ethane, etc., while acetylene, benzole and sulphur are other products. With a large amount of hydrocarbons present in a furnace, it is almost impossible to prevent carbonization in the steels as the gases that are commonly present, other than nitrogen, have no other effect on steels. Thus, some parts of the piece being hardened would be carbonized more than others and cause a variation in the hardness. To prevent this, the muffle type of furnace should be used. The instruction given with all high-grade steels is to heat in a muffle furnace so the products of combustion, or the flame, cannot attack the metal. The construction of the electric furnace, however, is such that it forms its own

muffle and the expense of renewing muffles is done away with. In the neutral atmosphere inside the electric or muffle furnace, the oxygen holds the nitrogen and the nitrogen holds the oxygen. Neither are active and they do not attack the steel. This is plainly seen, as far as the oxygen is concerned, by watching the steel that is being heated. No matter how long it is subjected to the temperature of the furnace, no scale forms on the steel while in this neutral atmosphere. Oxygen always attacks the exposed surfaces first and causes blisters or scale to form on them; therefore, its action is visible. When no scale forms, the elements in the air must be inactive. When the hot steel is exposed to the air, other forces cause the oxygen to become active, and scale forms rapidly until the steel has cooled to comparatively low temperatures.

In Fig. 4 is shown two electric furnaces that are in use in the Sprang & Chalfant Co.'s plant in Pittsburg, Pa. The furnace to the left is heated by resistance wires and is of the type that is commonly used for laboratory work. It is here used for hardening all steels that do not require a hardening temperature of more than 1800 degrees F., and for preheating high-speed steels which require a greater temperature for hardening. As the wires would burn out if the temperature were raised to about 2000 degrees, its practical working temperature should be kept below this; thus, 1800 degrees is a good maximum to establish. After preheating in this furnace, which is the cheapest in fuel consumption, high-speed steels are heated to the hardening temperature in the furnace on the right-hand side. This furnace is capable of withstanding a temperature of 2400 degrees continuously. It is the same type as shown in Figs. 1, 2 and 3.

Current Consumption and Operating Cost

The carbon resistance furnace to the right, with a heating chamber 12 inches wide, 18 inches deep and 8 inches high, can be brought up to the higher temperatures required for high-speed steel, with 30 kilowatts, in one hour and fifteen minutes, and then be maintained at this temperature with about one-half of this current. With an average amount of steel to heat, it can be operated during a ten-hour day with about 145 kilowatts. The wire resistance furnace on the left-hand side, with a heating chamber 12 inches wide, 26 inches long and 8 inches high, can be raised to its working temperatures for carbon steels in one hour and 30 minutes, with 15 kilowatts and then be held at this temperature with less than one-half of this current. The heat insulation is so effective that furnaces have been closed after turning off the current, and at the end of twelve hours the temperature had only dropped to between 700 and 800 degrees. Smaller furnaces with a heating chamber 7 inches wide, 12 inches deep and 5 inches high, only use one-half as much current.

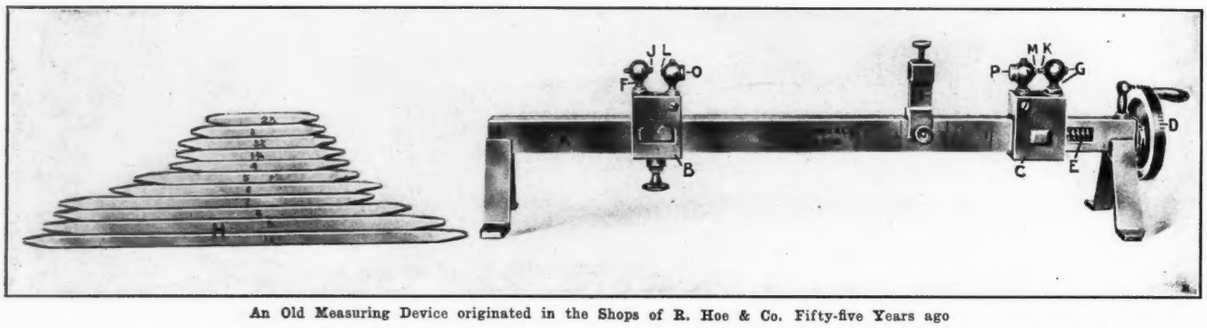
The current cost for an electric furnace is undoubtedly higher than the fuel cost for a gas-, oil- or coal-fired furnace of the same size, but when all other things have been taken into consideration, this current cost is minimized and the electric furnace can be made to compete commercially with other kinds. This is especially true when quality is a factor in the work heat-treated. The ease with which the temperature can be controlled and accurately maintained; the absence of scale or pitting; the decrease in warpage; the cleanliness of the work due to the absence of deposits of any kind; the overcoming of decarbonized spots; the lowering of the penetration of gases or other injurious elements, such as sulphur; and the uniformity in the hardness or temper of the steel, are all things which should be figured against the cost of fuel. In addition to this, the electric furnace can be so heat-insulated that the hand can be held on the outer shell or case without burning. This lowers the temperature of the hardening room and makes the working conditions so much better that operators are enabled to turn out more work. One company cites a case where they heat-treated three tons of cold-rolled steel per week, in the shape of razor blades, in six electrically heated furnaces with two operators; whereas, before their installation, it required fifteen men and sixty-five machines, that used gas and blast, for the hardening operations on the same tonnage. While this might be a case where the work was particularly adapted to electric furnaces, many others can doubtless be found, where a saving could be effected when all of the factors are figured into the cost.

[Since the foregoing article was written, a report has been received from the Timken-Detroit Axle Co. to the effect that the four furnaces mentioned have been in operation three months, and that each hour of the ten-hour work day averages 75 pounds of steel gears heated to the hardening temperature in each furnace. The average current consumption is 13 K. W. per hour for each furnace, costing 1¼ cent per K. W. The average cost per pound of steel hardened is a trifle more than 0.2 cent.—E. F. L.]

* * *

AN OLD BEAM MICROMETER CALIPER

The measuring machine shown in the accompanying illustration was found by the writer in the shops of R. Hoe & Co., New York City, manufacturers of printing presses. This interesting measuring device which is virtually a bench beam micrometer caliper was made by F. Corwin in 1858, who at the time was employed as a first-class toolmaker. The caliper is considered to be one of the first of its type ever developed. The beam *A* is laid off in twelve one-inch divisions, and the graduation lines and figures on the beam were all hand engraved. The adjustable jaw *B* is set on the line by the aid of a magnifying glass, while the other jaw *C* which is screw adjusted is set at division 1, the dial *D* being set at zero. The screw *E* is a square thread of ten pitch, and the dial *D* has 100 divisions, thus providing for readings of 0.001 inch.



An Old Measuring Device originated in the Shops of R. Hoe & Co. Fifty-five Years ago

When first made the caliper jaws were set on the inch mark by the aid of a magnifying glass, and fractional readings between the inch divisions were read off on the dial *D*. An addition was made to the machine so that it could be used for outside as well as inside measurements. This was accomplished by putting additional studs *F* and *G* in the jaws *B* and *C*. Hardened steel pins were inserted in these studs and acted as contact points between which the standard length gages shown at *H* were placed. These standards having square bodies were held in a support *I* clamped to the beam. To set the machine at a required dimension a standard length gage of the required length was placed between the measuring points and the dial set at zero. Then both outside and inside measurements could be taken, as the continued points of the measuring surfaces *L* and *M* (which have since been cut off) were in exact alignment with the points *J* and *K*. The machine was further remodeled by dispensing with the standards and using the additional measuring surfaces *O* and *P* in connection with the graduations on the dial. The jaws were set by standard plug gages and then by means of the graduations on the dial, readings exceeding the setting by one inch could be obtained. D. T. H.

ARBORS FOR SECOND-OPERATION WORK

VARIOUS TYPES USED FOR TURNING, BORING AND GRINDING, WITH EXAMPLES ILLUSTRATING APPLICATION

BY ALBERT A. DOWD*

Cylindrical work which cannot be completely machined in one setting and which requires concentricity of the various surfaces obviously makes necessary some method of holding

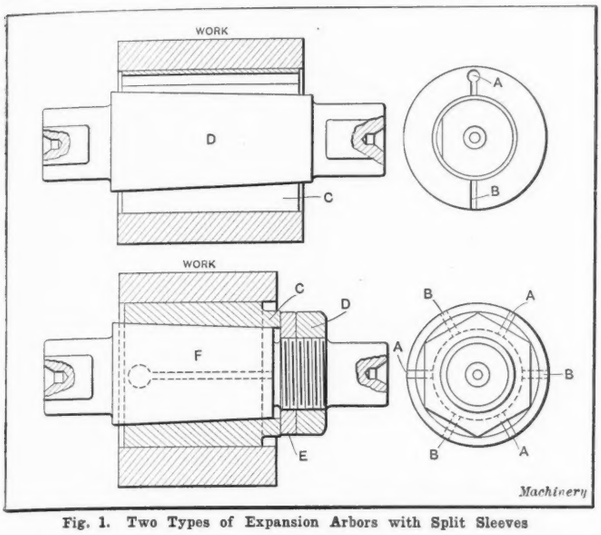


Fig. 1. Two Types of Expansion Arbors with Split Sleeves

it for the second operation which utilizes a previously machined surface for securing the proper location. When this surface is external, the use of soft jaws, a step-chuck or collet jaws is feasible, but when an internal surface is the locating

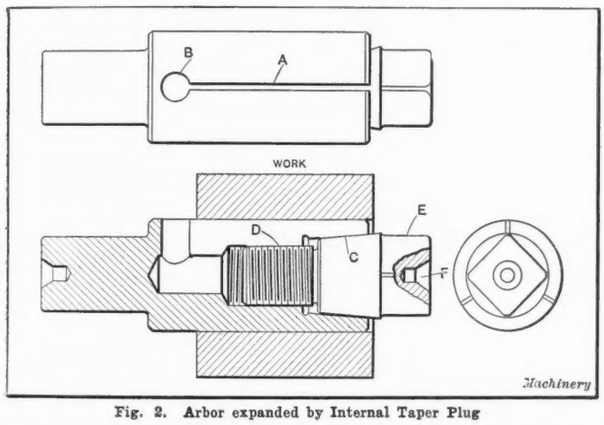


Fig. 2. Arbor expanded by Internal Taper Plug

point the most efficient method is conceded to be some form of arbor. This arbor may be either a plain stud made to fit the hole in question, or it may be so designed as to be susceptible of a certain amount of expansion and contraction in order to take care of slight variations in the finished hole. The degree of accuracy required in the finished product determines the form of arbor which should be used. If a variation of 0.002 to 0.003 inch in concentricity is permissible, a plain arbor with some method of driving the work will answer the purpose very well. When very accurate work is required, however, greater care must be used in the design, and the expanding type of arbor is commonly used.

Important Points in Design of Arbors

The fundamental features which tend to make an arbor thoroughly efficient are as follows: Expansion must be uniform along the entire periphery; release must be quick and easy; ample driving facilities must be provided; clamping the work must be effected without chance of distortion. As an additional refinement, provision may be made for truing up the arbor so that it will run accurately with the center line of the spindle.

Lathe Arbors

Let us first consider the arbors designed for use in the engine lathe, adapted to be held between centers and driven by means of a dog on one end. The arbor shown in the upper part of Fig. 1 is the simplest of all those which have a split sleeve or bushing capable of expansion or contraction. The mandrel *D* is slightly tapered and is flattened on each end to receive the dog for driving. The sleeve *C* is correspondingly tapered and is drilled entirely through at *A*, after which it is saw-cut at *B* to allow for expansion. This arbor is the poorest of all the expanding types in that the expansion is not uniform, being in two directions only, and it cannot be depended upon to give results which are absolutely accurate.

A much better arbor is shown in the lower part of the same illustration. It will be noted that the mandrel *F*, in addition to being tapered, is threaded on one end to receive the hexagon nut *D*. This does away with the necessity of

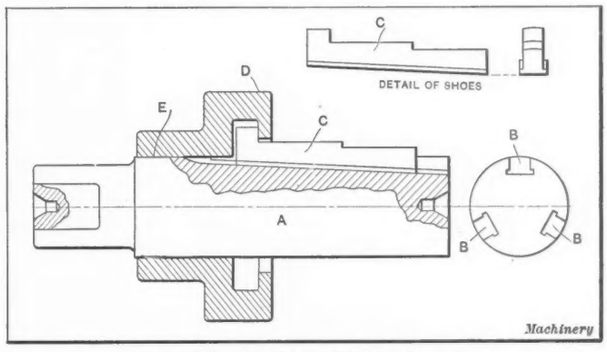


Fig. 3. Expanding Arbor of Sliding-shoe Type

using the arbor press to expand the sleeve. The collar *E* is interposed between the nut and the split bushing. This bushing *C* is saw-cut at *A* from one end and at *B* from the other, thus allowing a uniform expansion along its entire periphery. In this connection, it is well to note that the ends of the saw-cuts should be left tied together until after the sleeve has been hardened and ground; they can then be cut apart readily with a thin emery wheel. An arbor of this kind is mechanically correct and, if carefully made, should give results which leave nothing to be desired as far as accuracy is concerned.

Fig. 2 shows an arbor of a very different type, which might be called a solid expanding arbor. Three holes *B* are drilled 120 degrees apart and the saw-cuts *A* are milled as shown.

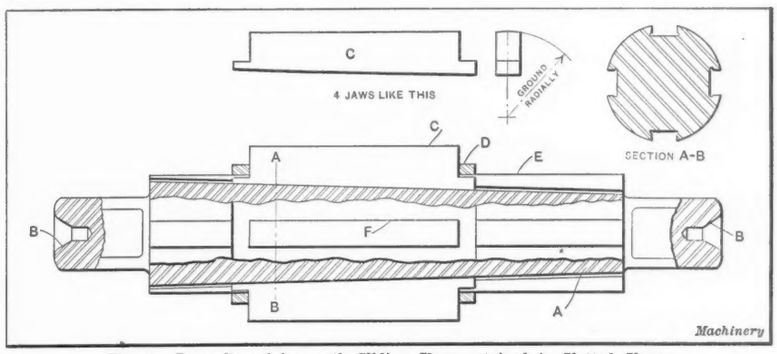


Fig. 4. Expanding Arbor with Sliding Shoes retained in Slotted Sleeve

The special screw *E* is tapered at *C* and threaded at *D* in the body of the arbor. The end of this screw is squared and contains the center *F*. When made as shown there is nothing

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in this arbor to commend it. In the first place, the expansion takes place at one end only and is not at all uniform, and, in the second place, the center *F* in the end of the screw cannot be depended upon to remain true for any length of time, even assuming that it may have been made reasonably true to start with, which, in itself, is a difficult machining proposition.

The arbor shown in Fig. 3 was at one time manufactured commercially by G. E. Le Count, South Norwalk, Conn., but the writer is unable to state whether it is on the market at the present time or not. It consists of the body *A* in which are milled the tapered slots *B*. The shoes *C* (also shown in detail in the upper part of the illustration) have a narrow rib running along each side and this rib engages with the grooves in the sides of the slots *B*, thus preventing the shoes from falling out. The collar *D* controls the action of the shoes and is ground to a sliding fit on the cylindrical portion *E* of the arbor. It may be noted that the shoes have two shoulders, thus increasing the range of the arbor. By providing shoes of various diameters the range can be increased considerably.

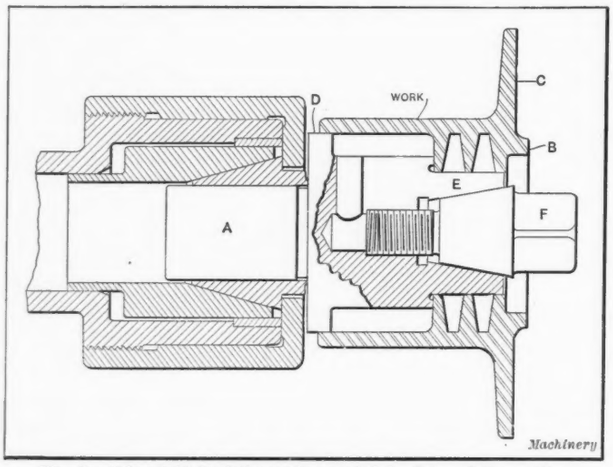


Fig. 5. Arbor held in Collet and expanded by Internal Taper Plug

W. H. Nicholson & Co., Wilkesbarre, Pa., manufacture the expanding arbor shown in Fig. 4 in various sizes and to suit various conditions. The body *A* is made of tool steel, hardened and ground to a cylindrical form. The centers are exceptionally large and are carefully rounded and lead-lapped after hardening. There are four slots in the body (shown in the section *A–B*), and these slots are relieved at each corner to prevent any interference by dirt. After hardening, the slots are also ground to insure truth. The jaws *C* (also shown in detail) are made of special steel and carefully ground to the same taper as the slots. After assembling, they are also ground radially on their own arbor. The sleeve *D* acts as a retainer for the jaws and is a running fit on the cylindrical portion *E* of the arbor. Four slots are cut through the sleeve and the jaws are held in position by them. These arbors are too well known to need further comment, as they are in general use throughout the country.

Turret Lathe Arbors

We will now go a step further and take up the type of arbors adapted for use in the horizontal turret lathe. It is well to bear in mind that arbors of this sort should be so designed that the work may be easily and quickly put on and taken off without the assistance of anything more than a wrench or spanner. Every precaution must also be used in clamping and driving the work, so that no chance for distortion is possible.

The arbor shown in Fig. 5 is somewhat similar in construction to that in Fig. 2, except that it is adapted to be held in collet jaws instead of on centers, as in the former instance. This arbor gave satisfactory results on the work for which it was used, the surfaces *B* and *C* being faced within the required limits of accuracy. The work was a push fit on the cylindrical portion *D*, the expansion taking place at *E*, controlled by the tapered screw *F*. In this case, the nature of the work permitted a slight margin of error and

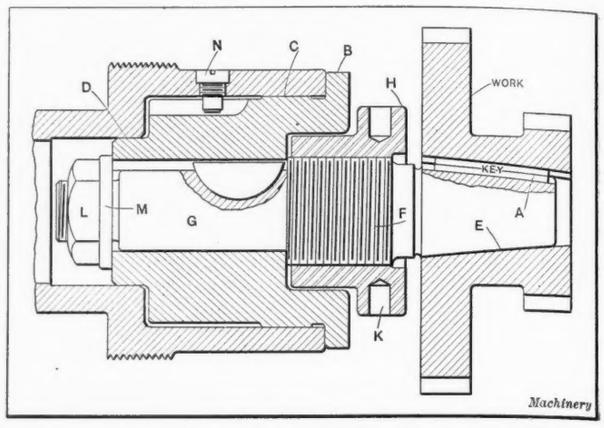


Fig. 6. Taper Arbor mounted in Spindle and equipped with Nut for removing Work

the expansion was only necessary to prevent chatter and act as a driver. The shank *A* is held in the collet jaws.

The arbor shown in Fig. 6 was made for the transmission gear which is shown in position. After the taper hole had been "chucked" in the work (which was done in a previous setting), the keyway *A* was cut for assistance in driving. The arbor body *B* is of cast iron, ground to fit the spindle at *C* and *D*. The stem *G* is of steel, hardened and ground to fit the body, into which it is keyed to resist the torsion of the cut. It is held in position and drawn back by the nut and collar *L* and *M*. The forward end is ground to the correct taper *E*, and the key is inserted at *A*. The portion *F* is threaded with a six-pitch Acme thread, right-hand, and the nut *H* is used to remove the piece after the work is finished, a piece of drill rod being used in the spanner hole *K* to turn the nut. The screw *N* prevents the body from turning in the spindle. This arbor has given very satisfactory results.

A somewhat extraordinary condition is shown in Fig. 7, which illustrates a steel automobile hub and arbor. In this

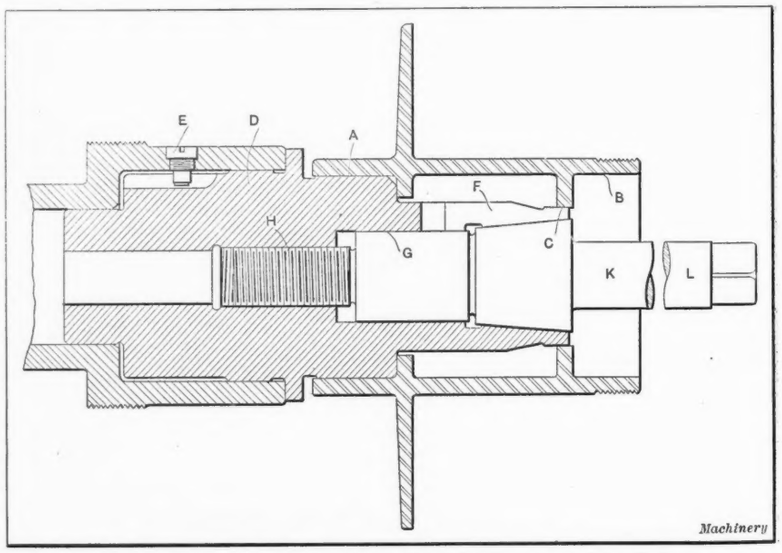


Fig. 7. Arbor with Split Expanding End and Pilot for steadying Tools

case, the bearing seats at *A* and *B* were required to be absolutely concentric. In order to assist in machining, the portion *C* was bored to size in the first setting, although no finish was required at this point. The body of the arbor *D* is of tool steel, hardened and ground at all important points. The small end is slotted in three places as shown at *F* and

is spring tempered at this end. The operating rod *K* has a very free thread at *H* and is ground to a snug running fit in the cylindrical portion *G* to insure a true running pilot *L*, regardless of the condition of the threaded part. All the tools used on surface *B* of the work were piloted by the stem *L*, thus securing absolute truth and concentricity of the ends *A* and *B*.

There are several important points to be noted in the construction of this arbor. First, the method of obtaining a true running stem *L* by means of the long cylindrical bearing at *G;* second, the use of the stem as a pilot for tools, thereby obtaining concentricity in the two ends of the work *A* and *B;* third, the positive location of one end at *A*, while using an expansion principle at the other end to insure rigidity and freedom from chatter. This arbor was very satisfactory, the two ends being within the extremely narrow limits of concentricity required.

An entirely different type is illustrated in Fig. 8. This is used for two different sizes of bronze bearing retainers, the use of adapters making this feasible. In the construction of this arbor, the body *A* is screwed directly onto the spindle nose, bringing up snugly against the end of the spindle at *B*. The body itself is of steel and is tapped out at *C* to receive the operating screw *E*. As in Fig. 7, the thread is a free fit, while the cylindrical portion *D* is

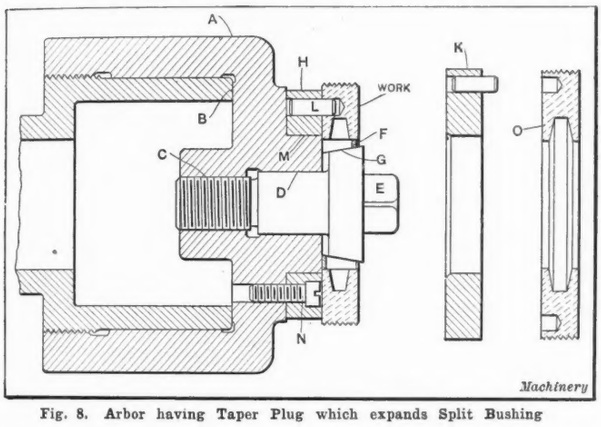


Fig. 8. Arbor having Taper Plug which expands Split Bushing

ground to a snug running fit to insure concentricity. The bushing *F* is saw-cut in six places, three cuts from one end running nearly through, and the other three in like manner, in order to allow uniform expansion of the bushing. Both the bushing and the operating screw are tapered correspondingly at *G*. The adapter *H* slips onto the body of the arbor and is located from shoulder *M* and secured in place by three screws *N*. A pin driver *L* in the adapter relieves the bushing of excessive strain. The larger retainer *O* (shown in detail) is also handled on this same arbor by using the adapter *K*. The results obtained with this arbor were perfectly satisfactory.

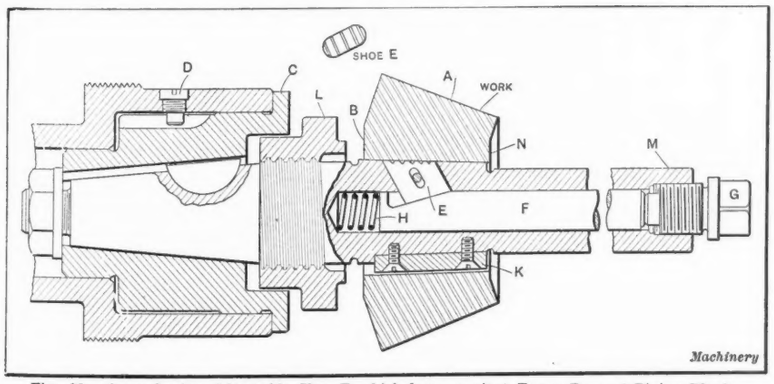


Fig. 10. Arbor having Adjustable Shoe E which bears against Taper Bore of Pinion Blank

In Fig. 9 the principles of expansion and contraction are both used in handling steel rifle part *A*. The permissible limits of error on this work were very close, so that extremely careful workmanship was necessary. This operation was the final one on the piece, after it had been machined all over, leaving 0.015 inch at *C* for truing to insure absolute concentricity between surfaces *B* and *C*.

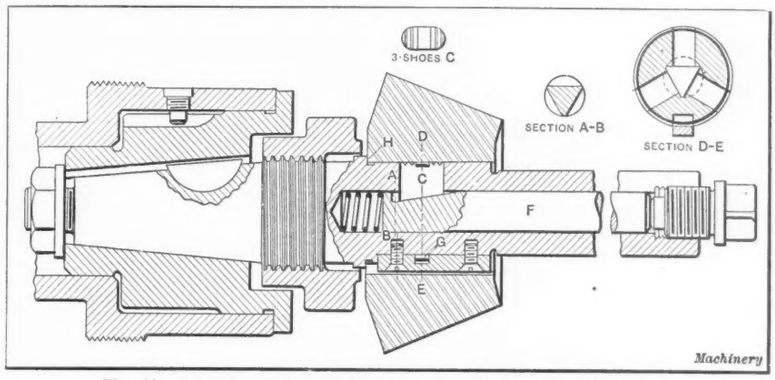


Fig. 11. Arbor for Pinion Blanks, equipped with Three Expanding Shoes

The machine to which this fixture was applied was equipped with collet mechanism, part of which was used in the operation. The body of the fixture *E* is of cast iron and is screwed onto the spindle nose, being secured against turning by the teat-screw *F*. The sides of the fixture were left open to enable the operator to reach in and grasp the work, in order

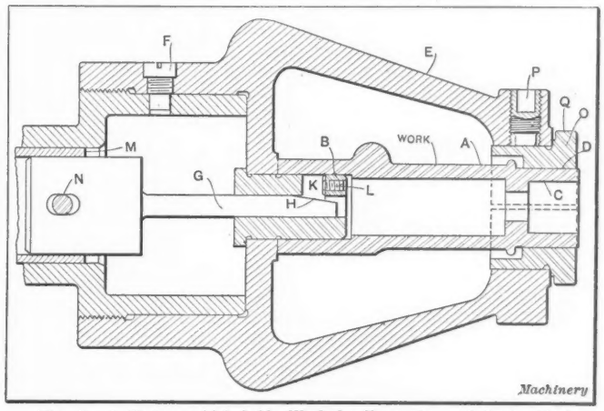


Fig. 9. A Fixture which holds Work by Expansion and Contraction

to guide it onto the locating bushing *B*. The operating rod *G* was milled at an angle on the forward end *H*, in order to force the pin *K* outward and thus insure rigidity at this point. The collet operating sleeve *M* is secured to the rod by pin *N*, so that the collet closing mechanism can be used to operate the rod. At the forward end of the fixture, the split bushing *O* is used to center the work which is gripped on the finished cylindrical surface *D*. The bushing is knurled at *Q* and is contracted by the action of the hollow set-screw *P*. All important surfaces were ground to an accurate fit and parts subject to wear were hardened. No trouble was experienced with this fixture and the work was machined within the limits of accuracy required.

The steel pinion blank shown at *A* in Fig. 10 has been previously faced at *B* and the taper hole carefully bored, leaving the remainder of the work to be accomplished at the setting shown. The body *C*, in this instance, is of cast iron and is held in position by the teat-screw *D*. The arbor is of tool steel, carefully hardened and ground. The shoe *E* is shaped as shown in the detail above. The operating rod *F* is forced inward by screw *G*, and its release is effected by spring *H* which bears against its inner end. It should be noted that the action of shoe *E* is both outward and backward; therefore it has a tendency to force the work back

onto the tapered portion. Obviously key *K* acts as a driver. In order to avoid any chance of springing the arbor out of true a small, special wrench is used for turning screw *G*, so that too much pressure cannot be applied. The nut *L* is threaded on the arbor with a coarse-pitch Acme thread and is of hexagon shape at the forward end. This nut is used to start the work off the arbor when the piece is finished. The stem of arbor *M* enters a bushing in the turret and acts as a support while the beveled surface of the work is being turned. This stem is also used as a pilot for the face mills which form the end of the pinion at *N*. This arbor while used for producing work of the best quality was somewhat fragile and required careful handling.

The pinion blank shown in Fig. 11 has a straight hole instead of a taper one, and the arbor for holding it, while somewhat similar in construction to that shown in Fig. 10, differs as regards a number of points. There are three shoes *C*, 120 degrees apart, controlled, as to their outward movement, by the operating rod *F*. These shoes are retained in their positions by the thin circular spring *G*. The shoulder *H* on the arbor acts as a positive longitudinal stop for the work. The various sectional views give a good idea of the construction. This arbor is also of tool steel and all important surfaces are hardened and ground. It gave very satisfactory results, but the rather delicate construction necessitated careful handling.

Arbors for Vertical Boring Mill and Vertical Turret Lathe Work

We now come to a class of work of larger size, which can be more conveniently handled in the vertical boring mill or the vertical turret lathe. Arbors for comparatively large work frequently develop into combination locating and holding devices, so that they are more nearly related to locating fixtures in the truest sense of the word. It is well to remember that in all fixtures of large size some efficient means

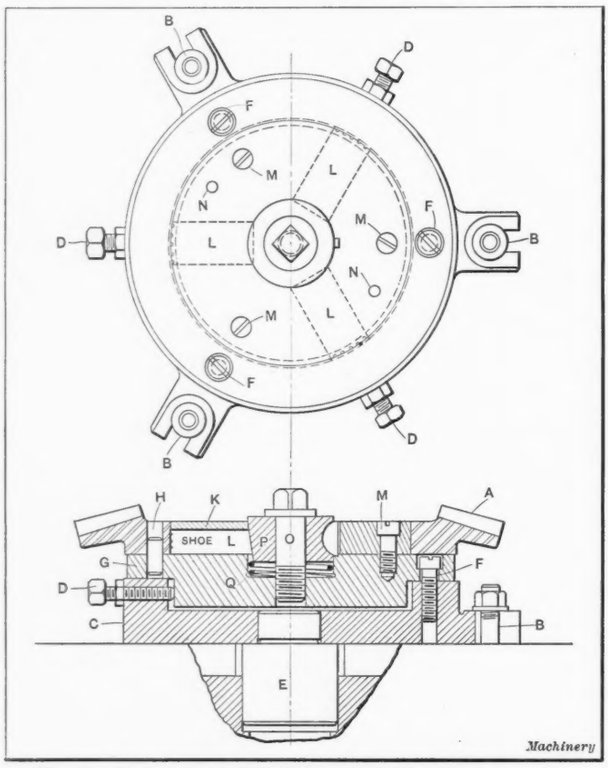


Fig. 12. Vertical Boring Mill Fixture for holding Bevel Gear—The Three Shoes L are forced outward by Plug in Center

of driving the work must be provided, for the thrust of the tool, incident to the cutting action, is much greater on work of large diameter; furthermore, the amount of stock to be removed is usually considerably more than on smaller work. The fixtures themselves should also be of exceptional strength and rigidly secured to the table to prevent movement or breakage.

The large automobile bevel driving gear shown in Fig. 12 is of alloy steel, and it has been previously bored and faced on the rear side; the screw holes were also drilled in a jig before placing the gear on the fixture shown. This fixture was rather expensive, being made entirely of steel (except the base, which is of cast iron), and all working parts were hardened and ground or lapped to a perfect fit. The base is located in the center of the table by means of the locating stud *E*, and is securely fastened down by the three T-bolts *B* which enter T-slots in the table. The adjustable part *G* is held onto the base by the three screws *F*. It will

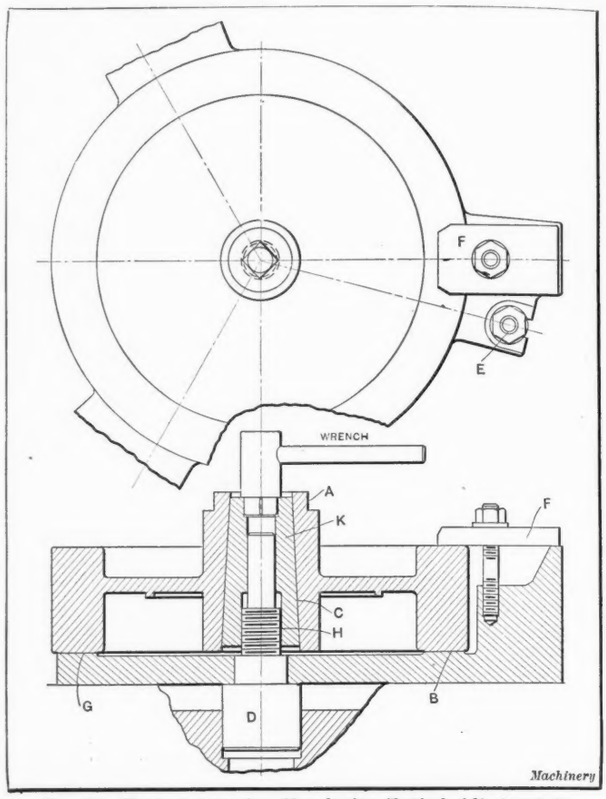


Fig. 13. Flywheel Centering Plug having Vertical Adjustment to compensate for Slight Variation between Bore and Rim Face

be noted that the screw holes have a certain amount of clearance over the body of the screw to permit adjustments to be made. The screws and check-nuts at *D* are for the purpose of conveniently adjusting the fixture. A pin-driver *H* engages one of the jig-drilled holes in the work. The upper plate *K* is square slotted at three points *L* to receive the shoes *L*. The screws *M* and the dowels *N* hold this plate in its proper position. The collar-head screw *O* forces down the plunger *P* on which three angular flat spots are milled. These angular surfaces control the action of the shoes *L* and force them out, uniformly, against the work, thus centering it. The spring *Q* simply aids in releasing the shoes.

This fixture is an exceptionally good one, for in its construction every care is taken to insure a true-running arbor and one which can readily be indicated for truth and brought into perfect concentricity by means of the adjusting screws. Its action was satisfactory in every respect.

Fig. 13 shows an automobile flywheel which has a finished taper hole and has been turned, bored and faced in a previous setting. It was essential that the surface *A* should be concentric with the taper hole. As it was practically impossible to machine the face of the flywheel *B* and the taper hole *C* so that they would always come in exactly the same relation to each other, it was necessary to make the taper plug adjustable in a vertical plane. The base of this fixture is of cast iron and is located centrally by means of plug *D* which accurately fits into the hole in the table. The base is clamped in position by three T-bolts *E* (see plan view) engaging the table T-slots. Three clamps *F* are used to clamp the work down on the annular rim *G* of the fixture. The plug *D* not only locates the fixture base, but extends above the latter and is threaded at *H*, while above

this portion it is cylindrical and is carefully ground to a running fit in the taper bushing *K*. The threaded portion mentioned is a very free fit, so as to permit the cylindrical part to do all the centralizing. In using the fixture, the bushing *K* is screwed down and the flywheel placed in position, after which, by the aid of the wrench, the bushing is raised until it bears in the taper hole. After this, the clamps *F* are swung around and tightened. This is a simple fixture, rather inexpensive, and one which was thoroughly dependable.

Fig. 14 shows a cast-iron double-bevel gear used on harvesting machinery, the gear rings *A* and *B* having cast teeth. These were not machined, thus leaving a rough surface by which to clamp the work, as some support was needed in order to properly machine the annular ring *C*. The cylindrical hole *D* and the end *E* were machined at a previous setting.

The cast-iron base of the fixture is centered by the stud *F* which fits the center hole in the table. This stud extends up through the fixture and is tapered at its upper end to receive the spit bushing *G*. This bushing is saw-cut in six places—three from each end—and is shouldered at its upper end so that the vertical movement can be controlled by the operating screw *H*. The collar *K* was pinned in place after the bushing was slipped over the screw. It will be noted that the vertical movement of the bushing is entirely mechanical, no springs being used to effect its release, as in previous instances. The positive locating point of the fixture is at *E*, but as it was necessary to have some support at *B* the four spring pins *L* were used; these bear against the rough surface of the casting and are prevented from being pushed down by the screws shown. The flat spot against

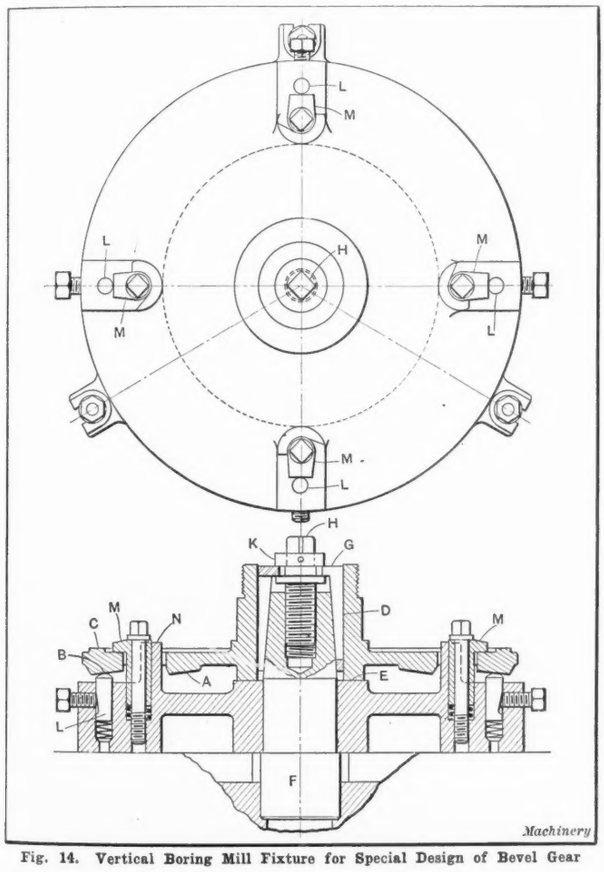


Fig. 14. Vertical Boring Mill Fixture for Special Design of Bevel Gear

which the screws bear is milled back at an angle of ten degrees. The rim of the gear has four cored holes and hook-bolts were necessary for holding and driving. These are shown at *M* in the illustration. In this connection, it is well to note that these hook-bolts are well backed up by a portion of the fixture *N*, for a hook-bolt which is not backed up in some way is worse than useless. This fixture was capable of rapid manipulation and the results obtained by its use were within the necessary limits of accuracy.

An Expanding Arbor for the Vertical Milling Machine

In one of the large automobile factories, considerable trouble was experienced in the manufacture of eccentric piston rings by the breaking of the rings as they were being cut off on an automatic machine. A new method was therefore devised by which the "ring pots" were bored and turned eccentric and then taken to a vertical milling machine where they were placed on the arbor shown in Fig. 15. The fixture of which the arbor forms a part is located in

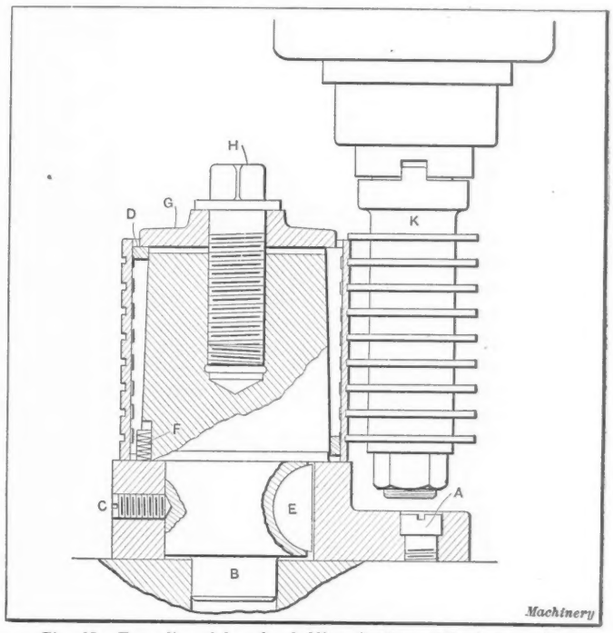


Fig. 15. Expanding Arbor for holding Casting while Gang-sawing Packing Rings

the center of a circular milling table by the stud *B*, and is secured to the table by means of the three screws *A* in the T-slots. The stud is tapered at its upper end to receive the split bushing *D*, and is secured by the pointed screw *C* and prevented from turning by the key *E*. The bushing was saw-cut in six places to permit expansion, and was also counterbored in three places at its lower end to make a pocket for the coil springs *F*. These springs tend to make the releasing of the split bushing easy after the work has been done. The collar *G* bears on the upper portion of the split bushing *D* and is operated by the screw *H* which is threaded into the body of the arbor.

A special arbor *K* in the spindle of the vertical milling machine was arranged with a gang of saw cutters properly spaced for the correct width of ring. As the table is revolved by power feed, the gang of cutters produce a set of nine clean and unbroken rings. It may be noted that the split bushing is relieved on its periphery at the points where the cutters pass through the work, in order to avoid dulling the cutting edges on the hardened surface. This fixture was made up very carefully and proved very satisfactory. To the best of the writer's knowledge, it is still in use although made over six years ago.

A Grinding Arbor for Piston Rings

The right-hand view, Fig. 16, shows an eccentric piston ring for a gas engine which has been bored, turned eccentric, ground parallel on the sides and split apart at the point *A*. The arbor shown to the left in the same illustration was used for grinding the periphery to make it perfectly cylindrical after it had been split and closed up at *A*. The body of the arbor *B* is of tool steel with generous centers in each end. These centers were lead-lapped after hardening and before grinding the cylindrical portion. The faces *C* and *D* are also carefully ground. The locating collar *E* is of tool steel, hardened and ground to a very close running fit on the arbor and at the point *H* where the rings fit. The portion *F* is knurled to give a good gripping surface for the hand when pulling back the sleeve. The spring detent *G* serves to hold the sleeve in position when it is pulled back

out of the way for grinding. The hole *K* is an air hole and is very essential, for as the parts are all very closely fitted the suction is so great that it is almost impossible to pull back the sleeve unless this relief hole is drilled. A longitudinal groove along the arbor would answer the same purpose, but is more likely to catch dirt and thus cause trouble. The nut *N* is of tool steel, has a coarse pitch thread and is made hexagon at the small end. The faces which bear against

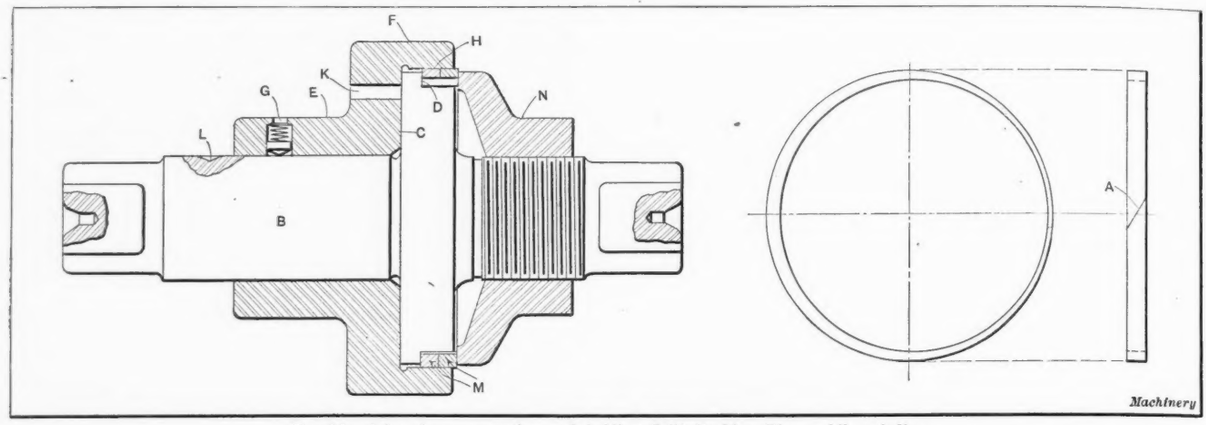


Fig. 16. Arbor for compressing and holding Split Packing Rings while grinding

the rings are ground parallel with the thread. When in use, the nut is slipped back out of the way and the two rings *M* are sprung into place inside the locating collar, after which the nut *N* is brought up against the rings and tightened. The locating collar is then pushed back out of the way, until the detent snaps into place, and the work is then ready for the grinding operation on the periphery. Arbors of this type are in daily use in nearly all of the automobile factories in this country.

The various types of arbors and fixtures illustrated and described in this article cover representative work of nearly all kinds, and may be modified to suit almost all possible conditions whether they affect the work part, the machine, or both.

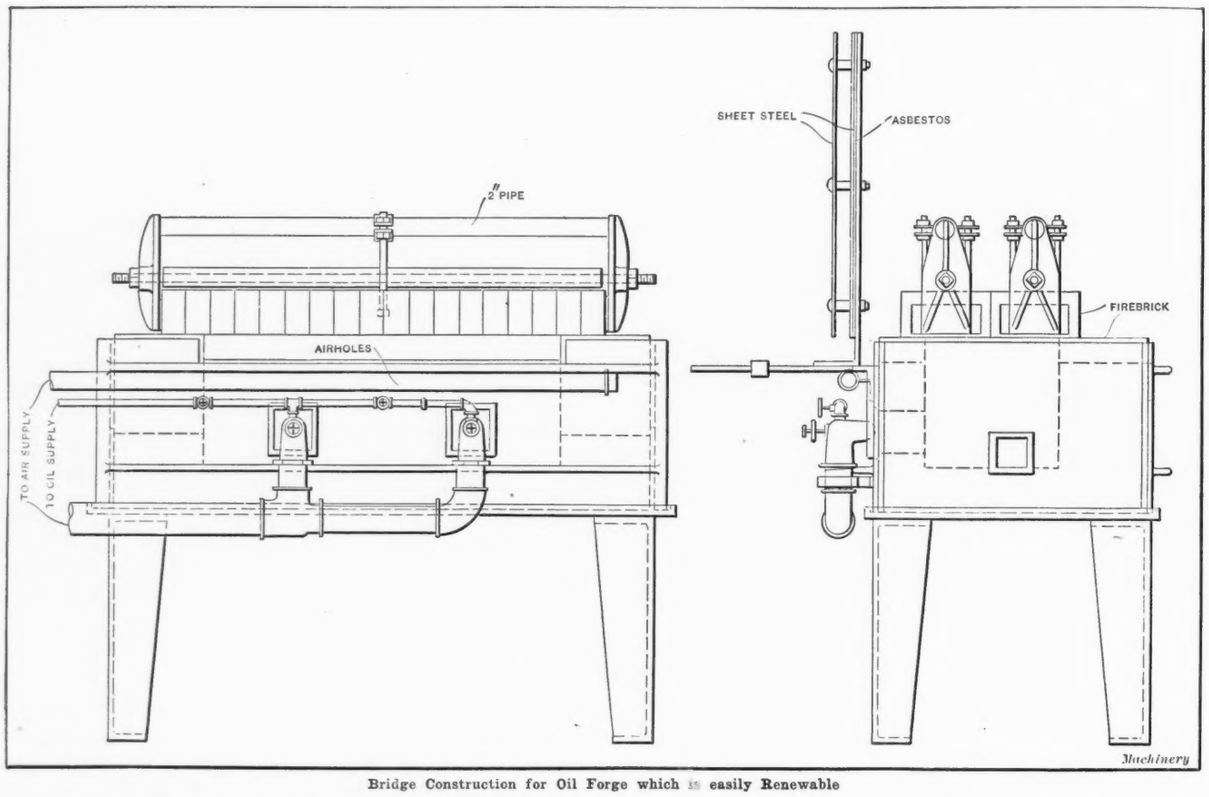
* * *

It is better to have a customer kick at the price than at the quality.

OIL FORGE FOR MACHINE BLACKSMITHING

BY M. W. W.

The oil forge illustrated herewith was built and tried out in a large shop which produces many varieties of forgings, and it was found to be so well suited for this class of work that two more similar forges were made. The distinctive feature of this forge lies in the bridge construction which is made of two rows of firebricks held together by the clamping mechanism shown in the illustration. It will be seen that this clamping mechanism consists of two clamp members which bear against the end bricks of the bridge construction. These clamps are carried by pieces of 2-inch pipe and are tightened by a bolt provided with a nut at each end. When these nuts are tightened, the firebricks are firmly held without requiring the use of fireclay or cement of any kind. It will be seen from the illustration that two rows of bricks are secured in this way to form the bridge of the forge, the bridge itself being held in place by gravity. With this form of construction, it is a very easy matter to renew the bridge work when the bricks have become so badly burned that replacement is necessary. The convenience of this construction will be evident to all who have maintained furnaces.



Bridge Construction for Oil Forge which is easily Renewable

SOLVING THE FUEL PROBLEM FOR THE MOTOR TRUCK

CHARACTERISTICS OF KEROSENE AS A FUEL FOR INTERNAL COMBUSTION ENGINES

BY HAROLD WHITING SLAUSON*

No sooner has the gasoline motor been well-nigh perfected, than the automobile designers and drivers find themselves face to face with another problem. Methods of carburetion, lubrication, and ignition have all been successfully developed, and the driver now looks for little trouble from these sources; but the success of the designers in eliminating these troubles has, in a sense, defeated its own purpose, for when the low price, reliability, and compactness of the gasoline engine began to solve so many power-producing problems, the demand for what had once been the "useless by-product" of the refineries increased to such an extent that gasoline is now a valuable fuel. A fifty per cent increase in price in a few months is not so important in itself, but when it is taken as an indication of further increases the problem assumes a serious aspect—serious for the motor truck owner, at least, if not for the driver of a pleasure car.

The reason for the slow acceptance of substitutes for gasoline is psychological as well as chemical and mechanical. The owner of a pleasure car is not as disturbed over the few cents increase in the cost of gasoline as might be expected; he argues that gasoline is a tested fuel that has given satisfaction, and he understands its characteristics perfectly. A small or even a large amount, spilled when filling the tank, causes no damage or annoyance, for the evaporation is rapid and no residue is left to collect dust. The heavier oils, such as kerosene, however, are slow to disappear by evaporation. The owner of a motor truck, however, has invested in the machine because he is convinced it will represent a dollars-and-cents saving over his former delivery or hauling system, and any device which will contribute toward economical operation will be given due consideration; furthermore, the fuel consumption of a motor truck is much higher than that of a pleasure car. A gallon of gasoline that will drive the latter twelve or fifteen miles will serve only for one-third or one-fourth that distance in a two- or three-ton business vehicle.

Kerosene as a Fuel for Internal Combustion Engines

In the search for new fuels that has been in progress since it has been evident that the supply of gasoline could not hold

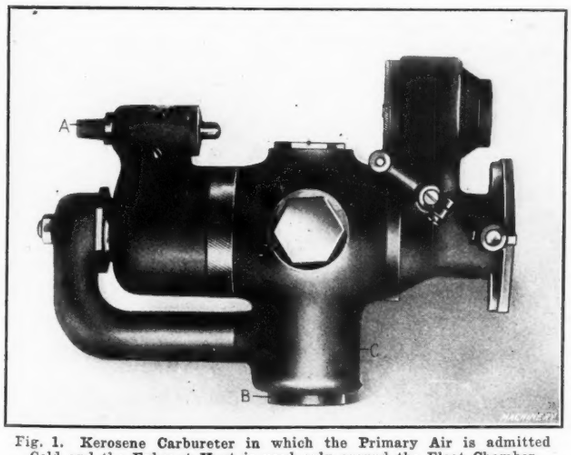


Fig. 1. Kerosene Carbureter in which the Primary Air is admitted Cold and the Exhaust Heat is used only around the Float Chamber

out, kerosene has stood foremost. This is logically due to several reasons, the chief of which is probably the fact that no change whatsoever need be made in the design of the gasoline engine in order to adopt it to the use of kerosene. In addition, kerosene is but one group lower than gasoline in the great hydrocarbon family of which petroleum is the parent, and the motor car driver therefore feels that he is not dealing with an absolutely new and unknown fuel; but of course, kerosene would not be regarded as a satisfactory solution of the fuel problem were it not present in large quantities in all grades of petroleum. The most valuable petroleum is the Pennsylvania crude, but even in this, gasoline is not present to a greater extent than three or four per cent, and in the poorer qualities, it is so scarce that no effort is made to distill it. Kerosene, on the other hand, is present

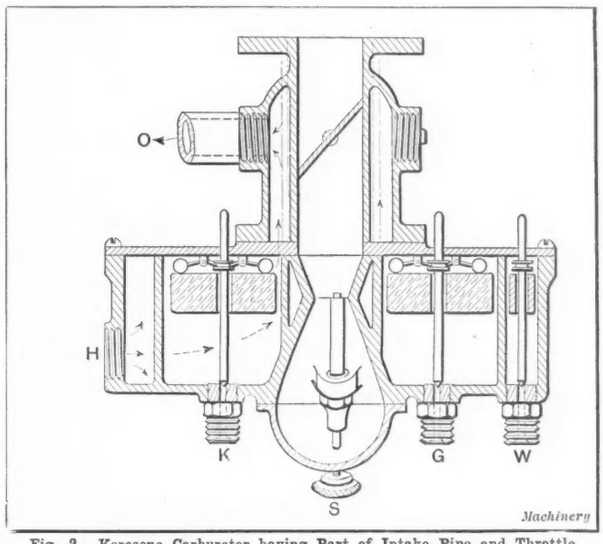


Fig. 2. Kerosene Carbureter having Part of Intake Pipe and Throttle Chamber jacketed for heating, as well as the Float Chamber

in varying quantities in practically every quality of petroleum and in some grades comprises as much as thirty or forty per cent of the total. Hence the supply of kerosene would seem to answer the fuel requirements of the internal combustion engines for years to come—or at least until the engines manufactured and in use today are worn out and the condition of the alcohol market has been so changed that the production of alcohol-burning motors becomes profitable.

When we say that the specific gravity of present-day gasoline on the Baume scale is approximately 62 and that of kerosene 45 or 48, we do not express the only difference that exists between the two liquids. Kerosene has a higher specific gravity and is therefore heavier and less volatile than gasoline, but it is by no means a poor substitute. The carbon content is different, and therefore kerosene in a gaseous state is as dissimilar from gasoline as when in a liquid form. Both before and after evaporation, the two fuels must be treated differently. The fact that kerosene is not volatile at ordinary atmospheric temperatures was the first problem to be met by the designers. It must be borne in mind that it is the *vapor* of the fuel, and not small globules, that must be mixed with the proper quantity of air and ignited in the cylinder of the internal combustion engine. A spray is not a vapor; the former may be mixed with the air but the liquid will separate and condense as soon as it strikes the cylinder walls. Engines of the Diesel type inject either kerosene or crude oil into the cylinder in the form of a spray, but previous to ignition, the compression is increased to 500 pounds per square inch, or more, which generates sufficient heat to gasify the fuel particles immediately and ignite them. The compression of the gasoline motor, however, does not exceed 70 or 80 pounds per square inch, and this is insufficient to enable the engine, when cold, to vaporize the non-volatile particles that may be introduced into it in the form of the finely divided spray. A gasoline engine will become hot in a very few minutes of operation, and this appealed to the designers as a convenient source of heat for increasing the temperature of the liquid kerosene to the evaporating point; therefore, three-fourths of all the kerosene carbureters used at the present time employ a bowl or float chamber to contain a small quantity of the liquid, and this is surrounded by a jacket that communicates with the exhaust pipe of the

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motor. A carbureter of this type is shown in Fig. 1. The fuel inlet is at *A* and the exhaust heat is admitted at *B*. The motor is started on a small amount of gasoline, and when the exhaust pipe has become sufficiently hot to vaporize the kerosene in the bowl, a two-way valve is turned which conducts the heavier fuel to the carbureter. The same carbureter is used for both the gasoline and the kerosene, although with some designs the gasoline is burned directly around the bowl containing the kerosene, to obtain the necessary heat.

Simple as such carbureters may appear, there are a number of problems that must be solved before the use of kerosene can give as good results as are obtained from gasoline. The fineness into which the kerosene jet should be divided, the amount of heat to which the fuel should be subjected, and the treatment of the mixture in order that the same "flexibility" as that delivered by a gasoline engine can be obtained from one using kerosene, are all subjects of vital interest to the designer and user. It has been found that the finer the spray into which the kerosene jet is divided, the more complete the combustion in the engine cylinder; atomization or pulverization probably more correctly describes the process to which the fuel should be subjected. The proper pulverization of the fuel, together with the application of heat, breaks it up into so fine a mist that actual gasification is not necessary, provided the intake manifold is made of such a shape and dimensions that the velocity of the mixture is kept high, to prevent condensation on the cool walls of the pipe. The temperature to which the fuel is raised before atomization is generally from 200 to 300 degrees, although in some carbureters the kerosene is subjected to a temperature of 600 degrees.

One of the drawbacks to the more general use of kerosene in automobiles has been its reputation for forming heavy deposits of carbon in the cylinder. When this condition exists, however, it is an indication of improper pulverization, condensation, or of faulty design or adjustment of the heat-

Fig. 3. Unique Type of Carbureter in which Spark Plug maintains a Continuous Flame in Path of Atomized Kerosene

and air-regulating apparatus. The best lubricating oils should be used when kerosene is employed as a fuel, but the formation of carbon in the cylinders or the presence of black smoke at the exhaust indicates that imperfect combustion is taking place.

Carbureter in which Variable Quantity of Water is added to Kerosene Mixture

An elaboration of the general type of kerosene carbureter previously referred to has been in successful use on many of the large traction engines used in the western section of this country. In this carbureter, cold air is supplied to the fuel immediately after pulverization, for it was found that this arrangement gave the greatest power and the best economy. It was also discovered that if the air admitted to this particular type of carbureter were heated, loss of power would result, attended by pre-ignition and other signs of an imperfect mixture. The unique feature of this carbureter, however, lies in an arrangement whereby a variable quantity of water is supplied to the mixture of kerosene spray and air before it is admitted to the cylinder. The water valve is connected with the crankshaft of the motor so that the supply of moisture to the mixture is increased as the throttle is opened and the spark advanced; when the motor is running

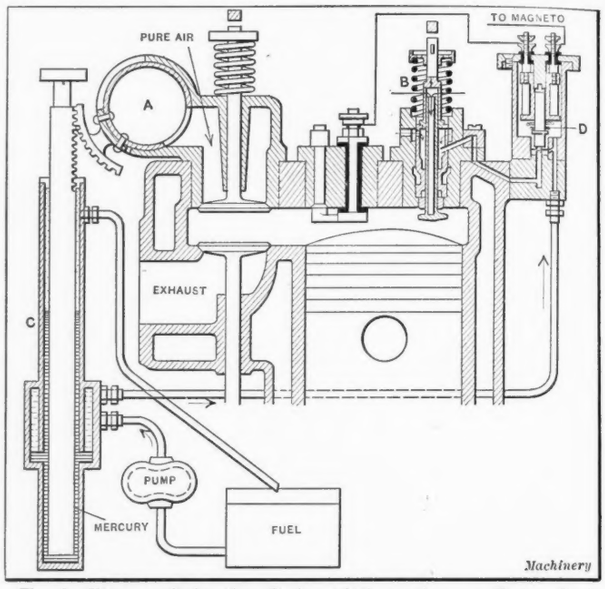

Fig. 4. Kerosene Carbureting Device which requires no Heat. It is equipped with electrically operated Valve for controlling Supply of Fuel

idle or is pulling very light loads no water is supplied to the fuel. The purpose of the water is to keep the temperature of the explosion within the limits from which the best results can be obtained, and also to assist in a more perfect combustion of the charge. At the same time that the water absorbs a portion of the excessive heat of combustion oxygen is liberated and the mixture is rendered more completely combustible. One of the troubles sometimes experienced with the use of kerosene in a gasoline motor is the inability of the engine to "pick up" with a load; full load can be maintained when it is once reached, but after throttling the motor—as on a hill, for example—the engine seems unable to respond when power is again desired. This lack of flexibility has been overcome by the introduction of the water spray that automatically accommodates its volume to the power demanded of the motor. It must be remembered, however, that the carbureter in question is designed especially for large, heavy-duty engines, and it should therefore be understood that the omission of the water spray from a kerosene carbureter designed for the average automobile in nowise indicates lack of flexibility in the power plant; in fact, many of the most successful carbureters in use on pleasure cars and trucks have no provision for the introduction of water into the air passage above the atomizing chamber.

The Wilcox-Bennett Carbureter Co., Minneapolis, Minn., makes a kerosene carbureter of the type described in the foregoing paragraph.

Heat for the Vaporization of Kerosene

While the heat for assisting in the vaporization of the kerosene is usually obtained from the exhaust manifold of the engine, the circulating water can sometimes be used for this purpose by jacketing the carbureter and connecting it with the water system of the engine. As the water in the jackets holds its heat for a greater length of time than does the exhaust manifold, it is evident that the motor could be started directly on kerosene—even after an appreciable interval had elapsed since its previous running—if the stored-

up heat in the water jackets were utilized. However, the operation of starting on gasoline, and then switching to kerosene, is neither difficult nor time-consuming and it is the surer method; but in order to obviate the necessity of even this slight trouble, some kerosene carbureters are supplied with an electrical coil placed within the vaporizing chamber. This coil is operated for a few moments by the current obtained from the lighting, starting, or ignition storage battery. But a short time is required to bring the finely divided spray from the atomizing nozzle to the vaporizing temperature, so that the current can soon be turned off, heat for further vaporization being obtained in the usual manner from the exhaust manifold of the engine.

Although the practice of heating the kerosene, either before or after pulverization, is almost universal, theories differ as to the advisability of warming the air with which this kerosene mist is first mixed. In one of the most successful types of carbureters the air is admitted cold after the kerosene has become thoroughly atomized by the mechanical action of the jet and the application of heat to the bowl. It is evident that the admission of the cold air will reduce the temperature of the resulting mixture to the point where condensation will be prevented when the charge comes in contact with the cool metal of the intake manifold. As previously mentioned, the intake manifold should be small enough so that the velocity of the mixture will be high and thus prevent condensation. By the use of cold air in medium-sized engines, however, this difficulty is overcome without the necessity of making any change whatsoever in the intake manifold of the engine. Another method of obtaining the same results, and one which is employed in one of the well-known kerosene carbureters designed especially for marine use, consists in jacketing not only the fuel bowl but the choke tube and throttle as well, so that the mixture is maintained at a high temperature throughout a good part of its journey to the hot cylinder. A carbureter of this type is shown in Fig. 2. The intake for the exhaust is at *H*, the outlet at *O*, the kerosene intake connection at *K*, the gasoline intake connection at *G*, the water intake connection at *W*, and the fuel spray nozzle at *S*. This type is manufactured by the Hampton Kerosene Carbureter Co., Inc., 1876 Broadway, New York City.

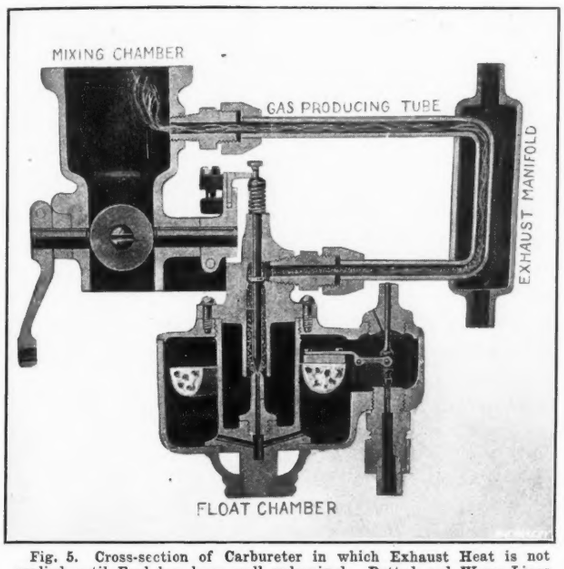

Fig. 5. Cross-section of Carbureter in which Exhaust Heat is not applied until Fuel has been well pulverized. Dotted and Wavy Lines indicate Transformation from Mist to Vapor after Application of Heat

Kerosene carbureter designers have long since discovered that the amount of heat supplied to the fuel before admission to the cylinder must be regulated to a nicety. It has already been pointed out that with insufficient heat, the kerosene is not properly vaporized. The application of too much heat, on the other hand, will result in what is known as the "cracking" process, in which the kerosene will be split up into its component parts, an ill-smelling exhaust will be ejected, and large quantities of carbon will be deposited on the piston and cylinder heads.

In one of the newest carbureters on the market (see Fig. 3) the mixture is given exactly the right composition in rather a novel way. The heat for assisting the vaporization of the fuel is obtained from the atomized kerosene itself, as soon as the motor is started, and no previous heating is required. The kerosene is atomized when cold in the usual manner; that is, by drawing it, by means of the suction of the motor, through a series of small orifices, which serves to break it up into globules, after which a strong current of air is passed over it for the purpose of further diffusion of the mist. If this mixture is discharged directly onto some cool surface, however, such as the hand, it will be observed that the kerosene will immediately condense and roll off in the form of drops. The atomizer and air inlet are at the top of the carbureter. Immediately below these is a small compartment into which projects the "business end" of a spark plug operated by a coil and set of dry batteries separate from those that may be used for the ignition system of the motor. As soon as the motor is turned over, the spark at the end of this plug is started. As this projects directly into the path of the recently atomized kerosene and air, a portion is ignited. This compartment is of such a size that only about two per cent of the kerosene spray is ignited, but this seems to be sufficient to "burn the excess carbon" out of the mixture and to transform it into an ideal combustible charge for the cylinders. This resulting mixture, if discharged into the air, appears in the form of a white cloud of vapor that does not easily condense, and seems to be as stable a gas as any yet used for internal combustion engines. This carbureter is manufactured by Alex. T. Porter Oil Utilities Co., 171 Broadway, New York City.

While the idea of burning a portion of the mixture directly in the path of the combustible charge may seem like a dangerous system, the flame is effectively prevented from spreading by the use of a wire gauze that holds the fire within the proper bounds in the same manner that the fine wire screen of the miner's lamp admits air to the burner but prevents any of the surrounding inflammable gases from becoming ignited. The location of this wire screen governs the proportion of the mixture that will be ignited by the spark plug, and the proper adjustment is important. A mica window is placed in one side of the spark plug chamber, so that the condition of the flame may be noted. The spark plug is used as long as the motor is in operation, but the inventor of the device is now working on a system which will require the use of the plug only at starting.

Kerosene Carbureting Device requiring no Heat

In view of the foregoing methods of carbureting kerosene, it is surprising to learn that a system has been devised in France which entirely does away with the application of heat, either to the raw kerosene or to the atomized mixture. In fact, a motor equipped with this device can be started when cold directly with kerosene as easily as though high-test gasoline were the only fuel used. The attachment can hardly be called a carbureter, in the ordinary sense of the word, inasmuch as it depends for its operation on several electrical and mechanical parts as well as physical properties, and requires a slight change in the design of the engine in order to make its installation satisfactory.

The first point in which this remarkable device differs from the ordinary carbureter lies in the fact that pure air only is admitted through the inlet valve. The amount of air so admitted is controlled by a slotted, hollow cylinder *A* (see Fig. 4), the orifice in which can be made to register with the opening in the inlet valve through an automatic control connected with the throttle or the gasoline pressure regulator. The raw kerosene is led from the pressure-regulating tank—into which it is forced by a rotary pump—into the atomizer *B* which is screwed into the cylinder head. This atomizer consists of an inverted automatic poppet valve, the head of which projects into the cylinder nearly over the head of the piston. The stem of this valve is hollow, and surrounding it is an auxiliary air space connected with the outer atmosphere. As the liquid kerosene under pressure rushes into the atomizer, it is broken up into fine particles and

united with the proper quantity of air admitted through the auxiliary opening and through the hollow stem. To be sure, this is not a *bona-fide* vapor (it is merely a fine spray), but it is admitted directly into the combustion space of the cylinder, mixed with the proper quantity of air entering through the inlet valve and immediately compressed; there has been no opportunity for condensation, for the atomization practically has taken place within the cylinder itself.

The pressure on the fuel is regulated by means of a variable column of mercury *C* extending into the space into which the kerosene is pumped. This pressure can be controlled by the same levers that throttle the supply of air admitted to the cylinder, but this would not be sufficient regulation to provide for the demands of the motor at all speeds, if the supply depended entirely upon this pressure and the suction of the piston in the cylinder. To obtain the proper regulation, there has been devised what is probably the most ingenious carburetion attachment to be found in use. Before the raw kerosene is admitted to the atomizing chamber, it is forced through a needle valve at *D*, the stem of which constitutes the armature of a solenoid. This solenoid is a coil of wire that is excited by the current derived from a low-tension magneto. The stem of the needle valve (assuming, of course, that it is made of a magnetic metal) serves as the plunger or armature of the solenoid and is drawn into the interior of the hollow coil whenever the current passes through the wire. When the coil is not excited, the needle valve is

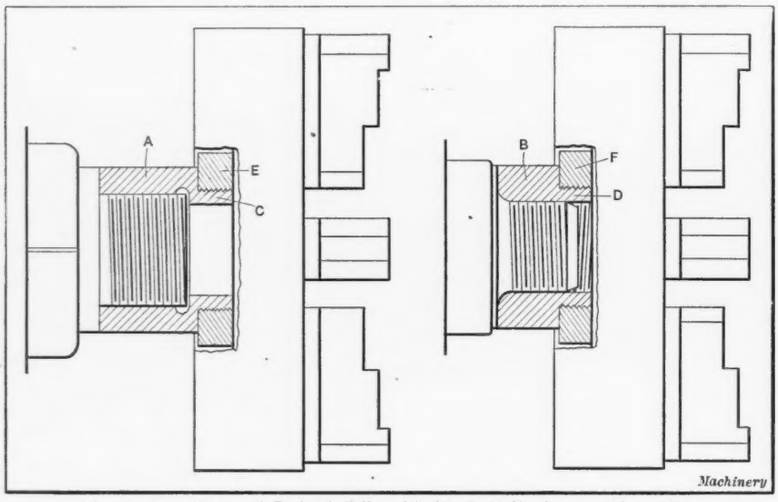

Fig. 1. Two Styles of Lathe Spindle with Standard Chuck mounted on them

held in place on its seat by means of a spring that effectually prevents the passage of fuel to the atomizer when the motor is not running. By means of an electric circuit-breaker which may be geared to the crankshaft of the motor, the number of current excitations or "pulsations" imparted to the coil may vary with the speed of the engine, and a supply of fuel proportionate to the demands of the engine will thus be obtained. This kerosene carbureting device has passed the experimental stage and is now used on many French cars.

To the ordinary motorist, familiar with the comparative simplicity and efficiency of the gasoline carbureter, these various devices for obtaining power from kerosene may seem somewhat complicated, but to the business man who will look deeper and see in them the real solution of the problem created by the constantly increasing cost of gasoline, they give evidence of the stability of the internal combustion engine and of its ability to adapt itself to whatever fuel may be used. These carbureters are in use today in all parts of the country, and if the owner of the pleasure car still prefers to pay the excessive price for gasoline, when a satisfactory substitute at half the cost is available, it may be but small consolation for him to know that the arrival of the time is inevitable when he will be forced to make the change. But whether the change will come soon or late, it is a satisfaction to the truck owner to know that one of the most important problems of his delivery and hauling system is being solved, and that the future of motor transportation is brighter than ever, even before that one universal fuel, gasoline, took its sudden upward leap in price.

* * *

INTERCHANGEABLE LATHE CHUCKS

BY GEORGE L. COLBURN*

Where threaded engine lathe spindles vary in pitch and diameter, it is evident that a chuck screw plate will not fit

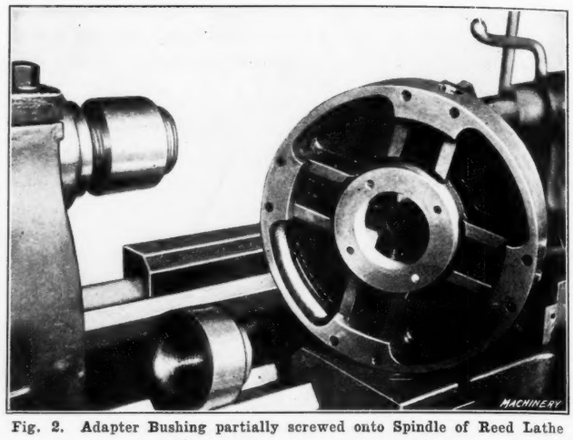

Fig. 2. Adapter Bushing partially screwed onto Spindle of Reed Lathe

more than one of the spindles. This difficulty may be overcome by using intermediate screw bushings. Referring to Fig. 1, the bushings provided for this purpose are shown at *A* and *B*. The threaded ends *C* and *D* of these bushings are made of the standard pitch and diameter to fit the screw plates *E* and *F* of the chucks. Threads are cut on the inside of the opposite ends of the bushings to fit the different lathe spindles on which they are to be used. It will be evident that this is the means of enabling a standard chuck to be used on lathe spindles of various diameters and thread pitches, the only additional equipment necessary being bushings having the proper inside thread.

Figs. 2 and 3 illustrate the screw plates fastened to the chucks by means of four screws. In Fig. 2 a screw bushing is partly screwed onto the spindle of a Reed engine lathe; a second screw bushing is

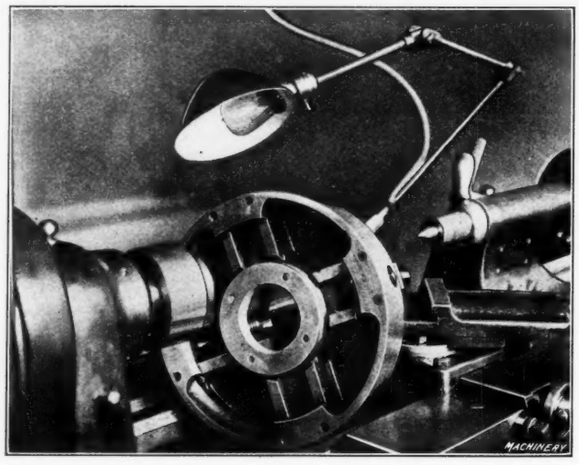

Fig. 3. Adapter Bushing partially screwed onto Spindle of Hendey Engine Lathe

shown resting on the bed of the lathe. In Fig. 3 is illustrated a screw bushing which is partly screwed onto the spindle of a Hendey engine lathe.

* Address: Boston Gear Works, Norfolk Downs, Mass.

KEROSENE FOR STEEL HEATING FURNACES

ARRANGEMENT OF A WELL EQUIPPED HEAT-TREATING DEPARTMENT—COMPARATIVE VALUES OF FUEL OIL AND KEROSENE

BY HARRY C. SPILLMAN*

During the last few months the price of fuel oil has steadily advanced and the oil refineries, in a number of states, have notified industrial plants that they will be unable to supply fuel oil after a certain date. At the present time it is almost impossible to enter into a contract with the refineries for a year's supply of this oil. This condition has caused many manufacturing plants to analyze the situation and try to find a substitute for fuel oil without installing new equipment in the heat-treating department.

The Continental Motor Mfg. Co., Detroit, Mich., has made numerous experiments with different kinds of oils and burners in order to be ready to meet the situation in case there is a shortage of fuel oil. Kerosene has proved most satisfactory after many experiments, and the data in this article show the results which have been obtained.

The furnaces show a very even temperature in all parts of the heating chamber, and a laboratory pyrometer fails to show over 10 degrees variation in any part of the heating chambers. Each furnace is equipped with both an indicating and a recording pyrometer (see Fig. 2) so that the operator can tell at a glance the temperature of each chamber. To facilitate the handling of material, the hearths of all furnaces, packing tables, trucks, quenching tanks and other equipment are made the same height from the floor. The door openings are made the full width of the heating chamber and are counterweighted.

The quenching tanks are of special design and are located in the center and opposite the furnaces so that they are readily accessible. Water, brine and oil are used for quenching, and by means of cooling tanks and circulating pumps the quenching mediums are kept at a constant temperature. The pumps deliver the liquid in the bottom of the tanks by means of perforated pipes which are protected by a wooden grating. This wooden grating also acts as a cushion for any parts which happen to fall in the tanks. The entire surface of the liquids is removed at a uniform rate by means of numerous outlets located near the top of the tank and connected with a common overflow pipe. The rate of flow can be governed by means of a valve fitted to the inlet pipe near the floor. The oil quenching tanks have a cover which can be closed very quickly in case the oil ignites. The quenching mediums are circulated through coils and are cooled by means of cooling water which is varied to suit conditions. The circulating pumps are direct motor-driven centrifugal pumps, located in the basement (see Fig. 3). The liquid is fed by gravity to these pumps, which does away with the troublesome feature of priming.

Fig. 1. Row of Furnaces and Quenching Tanks—Heat-treating Department of Continental Motor Mfg. Co.

The heat-treating room is of the most modern design and contains many unique features which are of interest. This department is housed in a fireproof building of structural steel and metal sash, and is entirely isolated from the other buildings. The steel sash has large ventilating sections and a monitor roof affords additional light and ventilation. All auxiliary apparatus, such as oil and circulating pumps, air compressor and storage and cooling tanks, is located in the basement, so that the entire first floor is given up to the furnaces and quenching tanks. A view of the first floor is shown in Fig. 1 which illustrates the general arrangement of the furnaces. These furnaces were made by the American Shop Equipment Co., and consist of four double-chamber case-hardening furnaces of semi-muffle type, with heating spaces 54 by 27 inches and 18 inches high. The combustion chambers are 27 inches wide by 7½ inches high. The two burners in front of each chamber are supplied with oil at 18 pounds pressure and air at 1½ pound pressure. The three heat-treating furnaces are of the same make and size. The casehardening furnaces are built up from the floor and are of heavy construction in order to withstand the service required of them.

The oil is fed to the burners by direct-connected, motor-driven rotary pumps, in duplicate. The oil is pumped from a 12,000-gallon tank located outside the building, and the surplus oil is returned to the storage tank by means of a relief valve and overflow. This system allows a constant

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pressure of oil at the burners at all times and the fuel oil is entirely drained back to the storage tank when the heat-treating room is not in operation. The elevation and plan, Fig. 5, show the storage tank and arrangement of the furnaces (oil and brine cooling coils, quenching tanks, etc.).

A General Electric turbo air compressor (Fig. 4) furnishes the necessary air for the burners at 1½ pound pressure. The

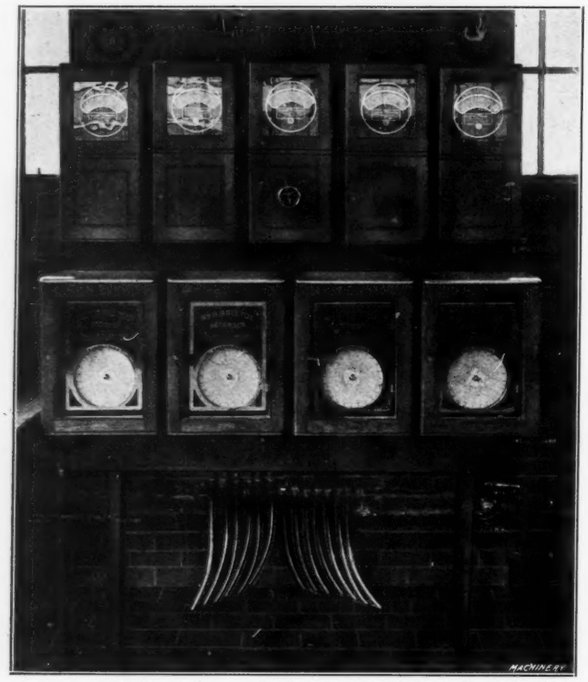

Fig. 2. Indicating and Recording Pyrometers of Plant shown in Fig 1

air lines were carefully laid out in order to reduce the friction to a minimum. The advantage of this type of air compressor is the constant pressure of air, regardless of the volume.

Tests were repeated for ten successive days on both kerosene and fuel oil. Both oils burned uniformly and needed very little attention after the proper regulation. One of the chambers of a double furnace was used for these tests, and in order to accurately measure the oil a tank of 60 gallons capacity was independently connected with one of the rotary pumps. The proper connections were made to maintain a constant pressure of oil, together with the necessary return

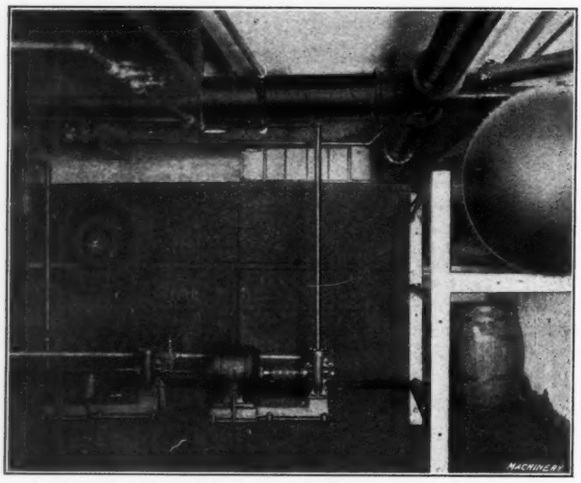

Fig. 3. Circulating Oil Pump in Basement of Plant shown in Fig. 1

piping for the overflow to the tank. A temperature record was obtained by means of smoke charts made on Bristol recording pyrometers. Both the indicating and recording pyrometers were carefully calibrated. The tests were made under actual working conditions and the same kind and quantity of material was heat-treated each day. The material placed in the chamber consisted of fifteen cam-shafts each weighing 21 pounds. Each cam-shaft was packed in a 3½-inch steel pipe with the carbonizing material. The total weight of each tube, with shaft and container, was 55 pounds. All the tubes were placed on a form made of narrow strips of bar steel. This form held the steel pipes in position and made the total weight in each chamber 950 pounds.

This department is only operated ten hours each day. The material is taken out at 5 P. M. and the furnaces are allowed to cool over night. In the morning the furnace pyrometers register about 700 degrees F. At 6.30 A. M. the burners are lighted and the material is placed in the furnaces which are continued in operation until about 5 P. M. The furnaces reach 1700 degrees about 9 A. M., and they show a uniform heat throughout the working chamber about one hour later. The tests were made under these conditions. The furnaces would have shown higher efficiency if they were run continuously twenty-four hours every day.

The points noted in making these tests were: Time required for the furnace to reach 1700 degrees; time to obtain

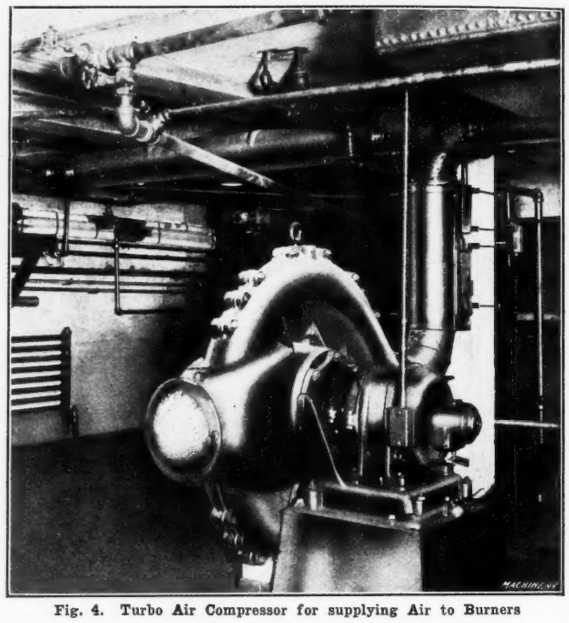

Fig. 4. Turbo Air Compressor for supplying Air to Burners

a uniform heat in the furnace; evenness of burning and regulation; and amount of oil consumed. The results of the tests follow:

	Fuel Oil	Kerosene
Time tests started	6.30 A. M.	6.30 A. M.
Time required for chamber to reach 1700 degrees F	9.00 A. M. (2 hr. 30 min.)	8.45 A. M. (2 hr. 15 min.)
Time for chamber to reach uniform heat	10.15 A. M. (3 hr. 45 min.)	9.45 A. M. (3 hr. 15 min.)
Time test stopped	4.45 P. M.	4.15 P. M.
Fuel consumption required for chamber to reach 1700 degrees F	26.5 gal.	23 gal.
Additional gallons to reach uniform heats	3.5 gal.	3 gal.
Number gallons for operating furnace 6½ hours after chamber reaches uniform heat	18 gal.	13 gal.
Number gallons per chamber, per hour after uniform heat is reached	2.77 gal.	2 gal.
Number gallons to heat-treat one pound of metal after uniform heat is reached	0.057 gal.	0.041 gal.
Specific gravity of fuel	41 deg. Baume	50 deg. Baume
B. T. U. per pound of fuel	19890	19917
Temperature of fuel	65 deg. F.	65 deg. F.

The comparative cost of fuel based on these tests shows that kerosene is from 23 to 25 per cent higher than fuel oil, but the tests also show that there is a saving of thirty minutes in order for the furnace to reach a uniform heat, and a saving of nearly 20 per cent in fuel, by using kerosene. Each burner has a ½-inch oil line and a 1½-inch air line and two burners are connected to each chamber. Power tests show that each burner requires 470 watts, which is equivalent to 0.63 horsepower.

* * *

Gradually the world is coming to the realization that even in the ordinary business affairs of life a man must consider the other fellow, and that he best serves himself who best serves his fellow-men.—*J. W. Pogue.*

THE TEST THAT COUNTS

BY WILLIAM A. WEBB*

It seems that steel makers have inexhaustible resources for bringing out new brands of high-speed steel which they claim to be better than the other fellow's. Although we continue to test out their samples, we sometimes find it difficult to tell just which one of the numerous brands is the best for our particular purpose. If we believe what the traveling salesmen tell us, however, the steel made by their respective companies is the best—but the method of testing has something to do with it.

I have listened to a great many interesting stories about how certain brands of steel have proved their wonderful superiority when tested on the glassy face of a worn car wheel, on a piece of chilled cast iron or on some other unusually hard metal that had been laid aside because the tools could not turn it. This method of testing might prove that high-speed steel is better than carbon steel, but when it comes to a show-down between different brands of high-speed steel, I believe this method would be wholly unsatisfactory, because the hardness of such metals is seldom uniform. The tool that gets the hardest part might stand up until it was just about to reach the softer metal and then give up, thus preparing the way for the next tool to make a good showing, although it might be of an inferior grade of steel. Then again, they tell about tests being made when the speed was shoved way up beyond all reasonable limits, and how one tool went two inches and another was unable to even start on the work. We have been guilty of such misdemeanors ourselves but after going through with a lot of such unsatisfactory testing, we came to the conclusion that the only way to get a fair comparison was to try the different steels out on regular work, where the stock was uniform, and let each tool show what it could do under everyday working conditions. This is the test that counts and gives the company the information it wants before buying steel in large quantities.

We have made it a practice of late years to take a selected number of sample tools, say half a dozen or whatever number it is desired to test, and grind them all to the same clearance and rake angles, and as near alike in every way as possible. These tools are put to work, one at a time, on regular stock where there is enough of it to allow each tool to make several trials. The speeds and feeds are arranged within reasonable limits and all the tools are set at exactly the same height in relation to the lathe centers (that is if a lathe is being used, which has been the case in most of our tests). A record is kept of how far each tool goes, and after they have all had six or eight trials apiece, we add up the totals and see how they compare. It appears to me that each tool should be given several trials before condemning or approving it, because in some cases it will make its best run the first time it is used after coming from the forge room, but more often the steel improves after the first or second grinding. Then again, a tool will make a freak run that looks incredible, but it will not do it every time, and after the test has been repeated several times the good tools will surely rise to the top. A test by this method can be repeated as often as desired without much extra expense to the company, as regular work is being turned out all the time. We never make expensive formed tools or milling cutters for other machines except from steel that has first been tested in the lathe and proved to be entirely satisfactory.

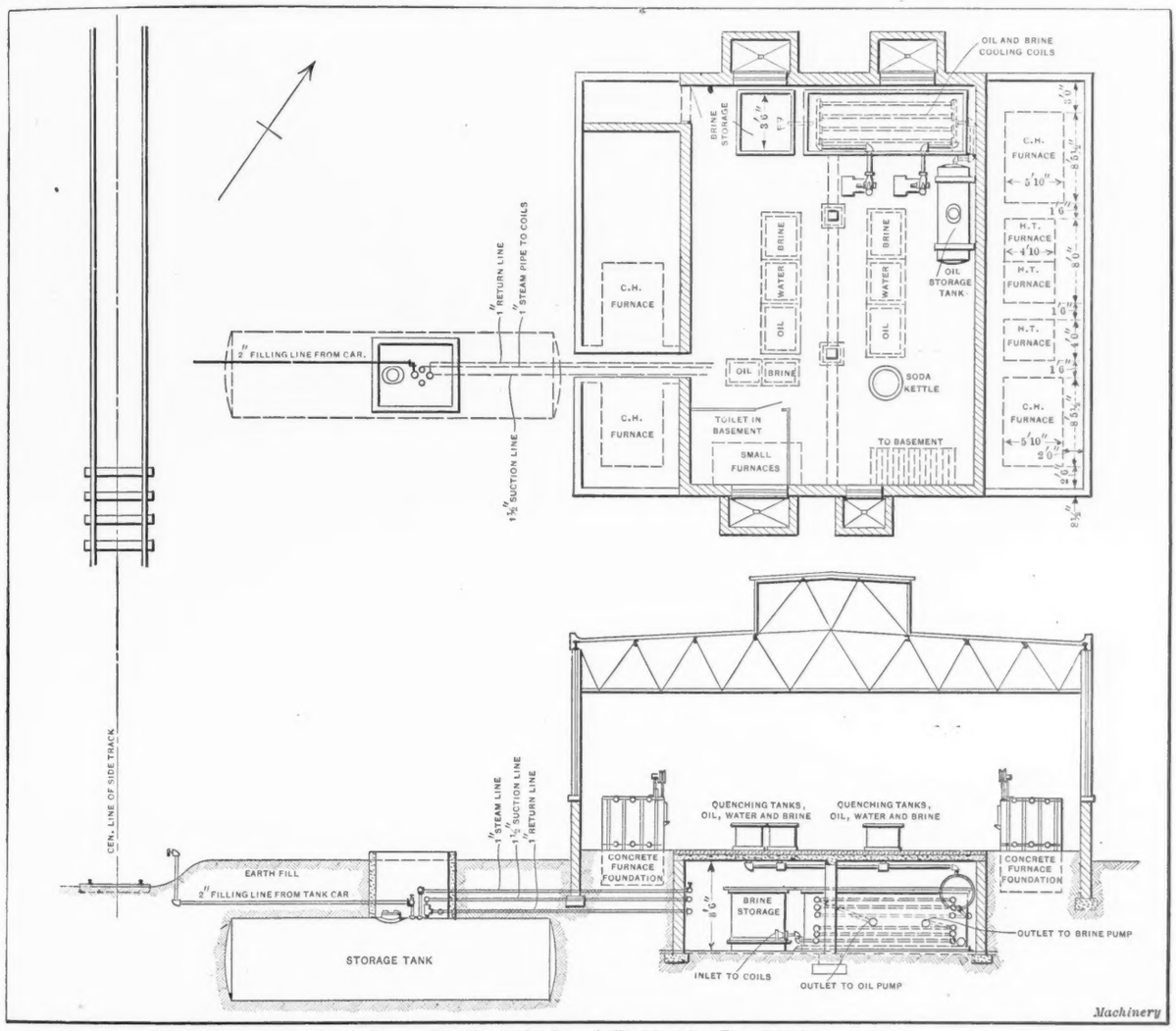

Fig. 5. Elevation and Plan of Heat-treating Department

* Address: 50 Mount Vernon St., Lowell, Mass.

DISK AND SQUARE METHOD OF DETERMINING ANGULAR SETTINGS

BY GUY H. GARDNER*

The method shown in Fig. 1 for determining angles for setting up work on a milling machine or planer possesses several advantages: No expensive tools are required, the method

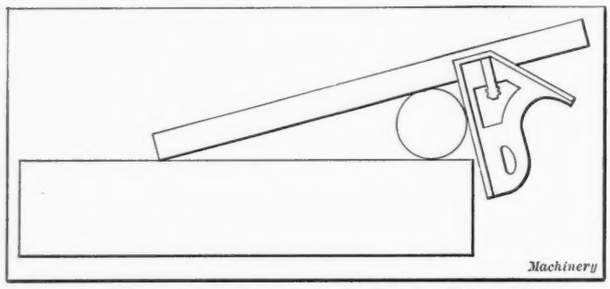

Fig. 1. Method of determining Angles by Use of a Disk and Square

can be quickly used, and the results obtained are quite accurate enough for any but the most exacting requirements. It will be seen from Fig. 1 that an ordinary combination square is used in connection with a disk, the head of the

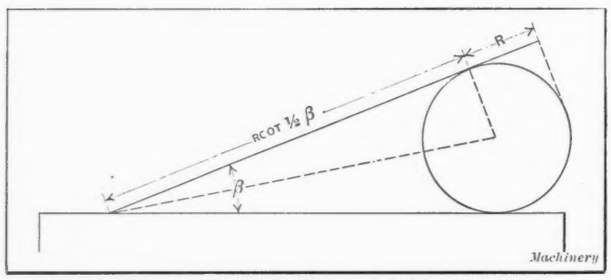

Fig. 2. Diagram illustrating Method of deriving Formula for setting of Square

square being set at different points on the blade according to the angle that is desired. Theoretically, a one-inch disk could be used for all angles from about 6 degrees up to a right angle, but in practice it is more convenient and accurate to employ larger disks for the larger angles. The table here given is calculated for three disks, 1, 2 and 4 inches in diameter.

When standard disks are not available, satisfactory substitutes can be made of machine steel, casehardened and ground. Satisfactory results can generally be obtained from disks which are left soft, although it is desirable to harden them when possible. It is a good plan to stamp on each disk, the diameter, the angles for which it is used and the points at which the head of the square is placed to obtain each angle.

The only inaccuracy resulting from this method is due to setting the square at the nearest "scale fraction" instead of at the exact point determined by calculation. This error is very small—less than two minutes in seventy-five of the angles in the table, and in five angles a trifle over three minutes—the error being negligible in practically all cases. When other than standard disks are used, the setting required for any desired angle can easily be found by multiplying one-half the diameter of the disk by the cotangent of one-half the desired angle, and adding to this product one-half the diameter of the disk. This rule is given in algebraic form by the following formula:

$$R \cot \tfrac{1}{2}\beta + R = \text{required setting.}$$

The derivation of this formula will be readily understood by referring to Fig. 2. If, for example, it is desired to set the work at an angle of 31 degrees 10 minutes, the setting to be made with a 3-inch disk, we have:

R = 1.5 inches

Cot 15 degrees, 35 minutes = 3.5856

R cot 15 degrees, 35 minutes = 5.3784

Then the required setting is 5.3784 + 1.5 = 6.8784. The nearest scale fraction is 6⅞ inches; using this setting, the angle obtained is 31 degrees, 11 minutes and 8 seconds, the error of 1 minute and 8 seconds being negligible for most classes of work.

For angles less than 6 degrees, smaller disks or size plugs may be used, but the method illustrated in Fig. 3 will gen-

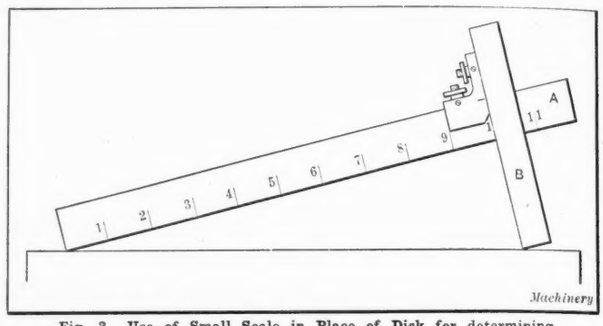

Fig. 3. Use of Small Scale in Place of Disk for determining Angles of less than Six Degrees

erally be found more convenient. It will be seen that a small scale B is held on the blade of the combination square, set so that its edge coincides with the 10-inch mark and extends below A a distance equal to ten times the tangent of the required angle. The scale B is graduated to 0.01 inch to facilitate making accurate settings. If greater accuracy is required, the scale B may be graduated to fortieths of an inch and a vernier placed on the attachment which carries the scale. With such an arrangement this device may properly be classified as a precision tool.

* * *

The electric welding process is employed to some extent in the manufacture of taps. Orders for extra long shanks are filled by making the threaded part the same as for regular taps and then welding to it a shank of open-hearth steel. The practice is both economical and rapid. Orders for special taps can be quickly and cheaply filled. Welding shanks to regular taps saves turning down the long shanks.

TABLE OF SETTINGS FOR ANGLES FROM SIX TO FIFTY DEGREES

Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction	Angle in Degrees	Diam. of Disk in Inches	Exact Setting	Nearest Scale Fraction
6	1	10.0406	10 3/64	17½	...	7.4971	7 1/2	29	...	4.8666	4 55/64	40½	...	7.4212	7 27/64
6½	....	9.3053	9 5/16	18	...	7.3137	7 5/16	29½	...	4.7983	4 51/64	41	...	7.3492	7 11/32
7	....	8.6749	8 43/64	18½	...	7.1402	7 9/64	30	...	4.7320	4 47/64	41½	...	7.2789	7 9/32
7½	....	8.1285	8 1/8	19	...	6.9757	6 31/32	30½	4	9.3359	9 11/32	42	...	7.2102	7 7/32
8	....	7.6504	7 21/32	19½	...	6.8196	6 13/16	31	...	9.2118	9 7/32	42½	...	7.1430	7 9/64
8½	....	7.2283	7 15/64	20	...	6.6712	6 43/64	31½	...	9.0915	9 3/32	43	...	7.0773	7 5/64
9	....	6.8531	6 55/64	20½	...	6.5300	6 17/32	32	...	8.9748	8 31/32	43½	...	7.0130	7 1/64
9½	....	6 5173	6 33/64	21	...	6.3955	6 23/64	32½	...	8.8617	8 55/64	44	...	6.9502	6 63/64
10	....	6.2151	6 7/32	21½	...	6.2672	6 17/64	33	...	8.7519	8 ¾	44½	...	6.8887	6 57/64
10½	....	5.9415	5 15/16	22	...	6.1446	6 9/64	33½	...	8.6453	8 41/64	45	...	6.8284	6 55/64
11	....	5.6927	5 11/16	22½	...	6.0273	6 3/32	34	...	8.5417	8 35/64	45½	...	6.7695	6 49/64
11½	....	5.4655	5 15/32	23	...	5.9151	5 59/64	34½	...	8.4410	8 7/16	46	...	6.7119	6 23/32
12	....	5.2572	5 ¼	23½	...	5.8077	5 13/16	35	...	8.3432	8 11/32	46½	...	6.6551	6 21/32
12½	....	5.0655	5 1/16	24	...	5.7046	5 45/64	35½	...	8.2480	8 ¼	47	...	6.5997	6 19/32
13	....	4.8885	4 57/64	24½	...	5.6057	5 39/64	36	...	8.1554	8 5/32	47½	...	6.5453	6 35/64
13½	....	4.7245	4 49/64	25	...	5.5107	5 33/64	36½	...	8.0652	8 1/16	48	...	6.4920	6 33/64
14	....	4.5722	4 37/64	25½	...	5.4194	5 27/64	37	...	7 9774	7 63/64	48½	...	6.4398	6 7/16
14½	....	3.4303	4 7/16	26	...	5.3315	5 21/64	37½	...	7.8918	7 57/64	49	...	6.3886	6 25/64
15	2	8.5957	8 1/32	26½	...	5.2469	5 ¼	38	...	7.8083	7 51/64	49½	...	6.3383	6 1/32
15½	....	8.3478	8 11/32	27	...	5.1653	5 11/64	38½	...	7.7271	7 47/64	50	...	6.2890	6 9/32
16	....	8.1153	8 7/64	27½	...	5.0867	5 3/32	39	...	7.6478	7 41/64	..	...	.....	.....
16½	....	7.8969	7 57/64	28	...	5.0108	5 1/64	39½	...	7.5704	7 9/16	....	...	.....	.....
17	....	7.6911	7 11/16	28½	...	4.9375	4 15/16	40	...	7.4950	7 ½	...	...	.....	.....

Machinery

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SETTING UP AND OPERATING AUTOMATIC SCREW MACHINES—2*

APPLICATION TO THE "ACME" MULTIPLE-SPINDLE AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON†

In the previous installment of this article, which appeared in the May number of MACHINERY, a general idea was given of the method employed in setting up and operating the "Acme" multiple-spindle automatic screw machine, together with the "assumed" method used in calculating the product per hour. In this connection, it was mentioned that while the "assumed" method of determining the product per hour was quickly obtained it had the disadvantage of not being clearly understood by those who were not familiar with the construction and operation of this type of multiple-spindle automatic screw machine. Before going more fully into this subject, it might be advisable to give all the data necessary for laying out a new job on this machine. Following this, the formulas used for making the calculations will be given, and a practical example illustrating the various points taken up in the article will be presented in order to make this subject more clearly understood.

Working Relations of Side-working Tool-slides to Work-spindles

In laying out a job on the "Acme" multiple-spindle automatic screw machine, it is necessary to know the working relations of the tools on the side-working tool-slides to the end-working tools, in order to provide for tool clearance, etc. This information is especially necessary when special tools have to be designed to use in these various positions. In Table I are given the principal dimensions of the side- and top-working tool-slides and their relations to the work-spindles when in the extreme forward and backward positions, the latter dimensions being given as maximum and minimum in the table. It will also be noted that on the Nos. 515, 52, 55 and 56 machines two positions are given for the side-working tool-slides. The reason for this is that the cam levers and brackets on these sizes of machines are provided with two pivot holes, thus making it possible to increase the travel of the slides without changing the cams operating them. The capacities or diameters of stock which can be formed and cut off with the levers fulcrumed in the two positions were given in Table I of the January installment of the series "Acme Multiple Spindle Automatic Screw Machine."

Working Relations of End-working Tool-spindles to Work-spindles and Side-working Tool-slides

In connection with Table II is presented a diagram illustrating the relations of the end-working tools, side-working tool-slides and work-spindles, and in the table the principal dimensions noted on the illustration are tabulated. These

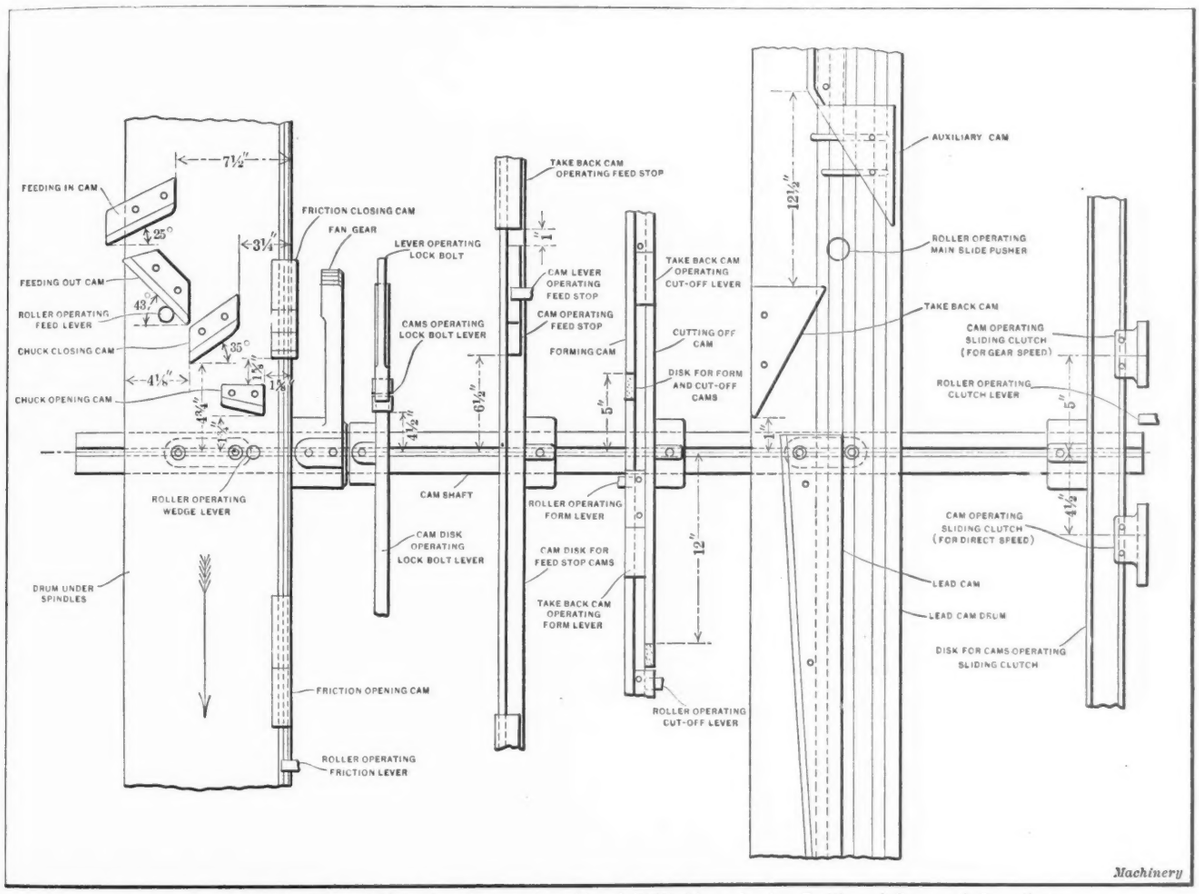


Fig. 9. Developed Plan View of Main Cam-shaft on Nos. 54 and 55 Machines showing Position of Cams and Operating Mechanism when Machine is indexing

data are necessary in order to determine the length of the shanks and bodies of the end-working tools and also their diameters. The extreme positions of the end-working tool-slide in relation to the face of the nose pieces enclosing the chucks are given by dimensions *H* and *I*, which are the minimum and maximum distances. The dimension *C* on the side-working slides is the distance from the inner edge of the tool slot to the face of the nose piece on the spindles when the center of the slide is directly over the center of the cam lever operating it. Of course this slide can be adjusted longitudinally on the machine, as was described in a previous article, in order to bring the cut-off and forming tools in the correct relation to each other and the work.

In laying out a job it is always advisable, whether standard or special tools are to be used, to determine whether there is sufficient clearance between the face of the tools and the ends of the work when the tool-slide is in its extreme backward position. This is necessary, of course, in order for

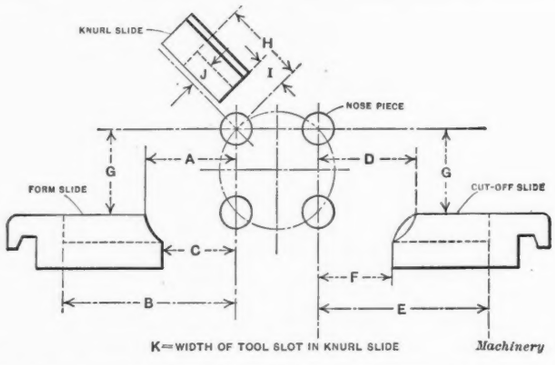
* "Setting up and Operating Automatic Screw Machines—1" appeared in the May, 1913, number of MACHINERY.

†Associate Editor of MACHINERY.

the cylinder to index. When designing special tools an endeavor should always be made to have the tool shank the full length of the hole in the tool-spindle. In order to decrease the liability to chatter and spring, it is preferable to have a tool with as long a body as possible, as this increases the rigidity of the tool considerably.

Another point to bear in mind is that the tools should be designed to correspond with the positions that they occupy on the work; that is to say, the box-tool which performs the second cut on a piece should extend out further than the first box-tool a distance equal to the advance made on the work by the first tool, and hence must be considerably longer. In laying out the job, therefore, it is essential that this particular point be borne in mind so that all tools in the main tool-slide will clear the work. This is particularly important, as on this machine the tools work from the end on different bars at the same time, and as these bars all project the same distance from the face of the chuck it is

TABLE I. PRINCIPAL DIMENSIONS GIVING RELATIONS OF FORMING SLIDES TO WORK-SPINDLES



Number of Machine	Dimensions of Form Slide in Inches: Top Pivot Hole in Cam Lever and Bracket A Max.	A Min.	B Max.	B Min.	C Max.	C Min.	Bottom Pivot Hole in Cam Lever and Bracket A Max.	A Min.	B Max.	B Min.	C Max.	C Min.	Dimensions of Cut-off Slide in Inches: Top Pivot Hole in Cam Lever and Bracket D Max.	D Min.	E Max.	E Min.	F Max.	F Min.	Bottom Pivot Hole in Cam Lever and Bracket D Max.	D Min.	E Max.	E Min.	F Max.	F Min.	Cut-off and Form Slide G	Principal Dimensions of Knurl Slide in Inches: H Max.	H Min.	I Max.	I Min.	J	K
51	$3\frac{1}{16}$	$2\frac{1}{8}$	$6\frac{9}{16}$	$5\frac{5}{8}$	$2\frac{1}{16}$	$1\frac{1}{16}$	..	..	..	..	..	..	..	..	$5\frac{7}{8}$	$5\frac{1}{8}$	$1\frac{3}{4}$	$1\frac{1}{16}$	..	..	..	..	..	..	$2\frac{3}{16}$	$5\frac{1}{4}$	$4\frac{5}{8}$	$2\frac{1}{2}$	$1\frac{13}{16}$	$\frac{5}{8}$	$\frac{5}{8}$
515	$3\frac{1}{8}$	$2\frac{1}{4}$	$6\frac{7}{8}$	6	2	$1\frac{5}{8}$	$3\frac{13}{16}$	$2\frac{1}{2}$	$7\frac{5}{8}$	6	$2\frac{11}{16}$	$1\frac{1}{16}$	$3\frac{1}{4}$	$2\frac{1}{2}$	$6\frac{3}{4}$	$6\frac{1}{4}$	$1\frac{13}{16}$	$1\frac{3}{16}$	$3\frac{5}{8}$	$2\frac{1}{2}$	$7\frac{15}{16}$	$6\frac{1}{16}$	$2\frac{7}{16}$	$1\frac{3}{16}$	$2\frac{13}{16}$	6	5	3	$2\frac{1}{16}$	$\frac{3}{4}$	$\frac{3}{4}$
52	$3\frac{1}{16}$	$2\frac{1}{4}$	$6\frac{13}{16}$	6	$1\frac{13}{16}$	$1\frac{5}{8}$	$3\frac{3}{4}$	$2\frac{1}{4}$	$7\frac{7}{16}$	6	$2\frac{1}{2}$	$1\frac{3}{16}$	$2\frac{15}{16}$	2	$6\frac{7}{16}$	$5\frac{15}{16}$	$1\frac{5}{8}$	$1\frac{1}{16}$	3	$2\frac{3}{8}$	$6\frac{7}{8}$	$5\frac{1}{2}$	$2\frac{1}{16}$	$1\frac{1}{16}$	$3\frac{3}{8}$	$6\frac{5}{16}$	$5\frac{1}{2}$	$3\frac{3}{8}$	$2\frac{1}{4}$	$\frac{13}{16}$	$\frac{13}{16}$
53	4	$3\frac{1}{4}$	$9\frac{1}{8}$	$8\frac{3}{8}$	$2\frac{13}{16}$	$2\frac{1}{16}$	..	..	..	..	..	..	$3\frac{1}{8}$	$2\frac{15}{16}$	$9\frac{1}{8}$	$8\frac{3}{8}$	$2\frac{7}{8}$	2	..	..	..	..	..	..	$4\frac{5}{16}$	$7\frac{9}{16}$	$6\frac{5}{16}$	4	$2\frac{1}{16}$	$\frac{3}{4}$	$\frac{3}{4}$
54	$4\frac{1}{4}$	$3\frac{7}{16}$	10	$9\frac{3}{16}$	$2\frac{3}{4}$	$1\frac{13}{16}$	..	..	..	..	..	..	$4\frac{1}{16}$	$2\frac{15}{16}$	$10\frac{3}{8}$	$9\frac{3}{16}$	3	$1\frac{7}{8}$	..	..	..	..	..	..	$5\frac{3}{8}$	$7\frac{15}{16}$	$6\frac{7}{8}$	$4\frac{5}{16}$	$3\frac{5}{16}$	$\frac{7}{8}$	$\frac{7}{8}$
55	$4\frac{3}{8}$	$3\frac{1}{2}$	10	$9\frac{1}{8}$	$2\frac{9}{16}$	$1\frac{11}{16}$	$4\frac{9}{16}$	$3\frac{1}{2}$	$10\frac{3}{16}$	$9\frac{1}{4}$	$2\frac{13}{16}$	$1\frac{11}{16}$	4	$2\frac{15}{16}$	$10\frac{1}{4}$	$9\frac{3}{16}$	$2\frac{15}{16}$	$1\frac{7}{8}$	$4\frac{1}{4}$	$2\frac{15}{16}$	$10\frac{1}{2}$	$9\frac{3}{16}$	$3\frac{3}{16}$	$1\frac{7}{8}$	$5\frac{3}{8}$	$8\frac{1}{16}$	$6\frac{7}{8}$	$4\frac{1}{2}$	$3\frac{1}{4}$	1	1
56	$4\frac{5}{16}$	$3\frac{1}{2}$	$10\frac{11}{16}$	$9\frac{13}{16}$	$2\frac{13}{16}$	$1\frac{7}{8}$	$4\frac{15}{16}$	$3\frac{1}{2}$	$11\frac{1}{4}$	$9\frac{13}{16}$	$3\frac{1}{4}$	$1\frac{7}{8}$	$4\frac{9}{16}$	$3\frac{5}{8}$	$10\frac{15}{16}$	$9\frac{13}{16}$	$2\frac{11}{16}$	$1\frac{7}{8}$	$5\frac{1}{16}$	$3\frac{5}{8}$	$11\frac{3}{4}$	$9\frac{15}{16}$	$3\frac{7}{16}$	$1\frac{7}{8}$	$6\frac{7}{8}$	$9\frac{1}{16}$	$7\frac{7}{8}$	$5\frac{1}{8}$	$3\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{32}$

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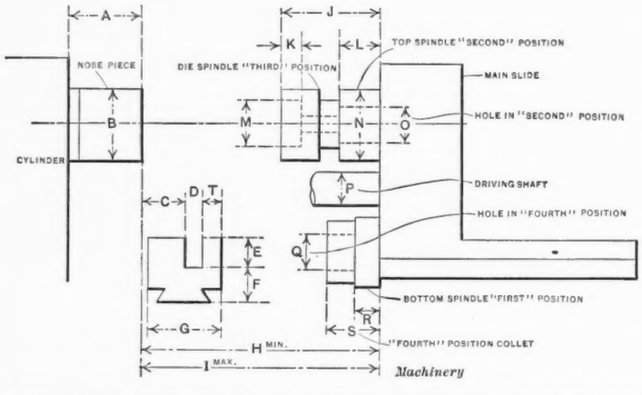
TABLE II. PRINCIPAL DIMENSIONS AND RELATIONS OF END-WORKING TOOLS TO WORK-SPINDLES AND FORMING SLIDES



Number of Machine	Principal Dimensions in Inches: Nose Piece A	B	Form Slide C	D	E	F	G	T	Cut-off Slide C	D	E	F	G	T	Main or Tool Slide H	I	J	K	L	M	N	O	P	Q	R	S
51	$1\frac{17}{32}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{19}{32}$	$1\frac{1}{32}$	$\frac{27}{32}$	3	$1\frac{1}{16}$	$\frac{3}{4}$	$\frac{19}{32}$	$1\frac{5}{32}$	$\frac{23}{32}$	3	$1\frac{25}{64}$	$3\frac{13}{32}$	$7\frac{31}{32}$	$2\frac{9}{32}$	1	$\frac{13}{16}$	1	$1\frac{13}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{13}{16}$	$1\frac{5}{8}$
515	2	$2\frac{1}{4}$	$\frac{15}{16}$	$\frac{19}{32}$	$1\frac{1}{16}$	$\frac{27}{32}$	3	$1\frac{1}{16}$	$\frac{1}{16}$	$\frac{19}{32}$	$1\frac{9}{16}$	$\frac{23}{32}$	3	$1\frac{17}{64}$	$3\frac{5}{8}$	$8\frac{5}{8}$	$2\frac{1}{4}$	1	$\frac{15}{16}$	1	$1\frac{15}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$2\frac{1}{4}$
52	2	$2\frac{15}{32}$	$1\frac{5}{8}$	$\frac{19}{32}$	$1\frac{1}{16}$	$\frac{27}{32}$	3	$1\frac{1}{64}$	$\frac{9}{16}$	$\frac{19}{32}$	$1\frac{3}{16}$	$\frac{23}{32}$	3	$1\frac{17}{64}$	$3\frac{1}{4}$	$9\frac{1}{8}$	$2\frac{1}{4}$	1	$1\frac{15}{16}$	1	$1\frac{15}{16}$	$\frac{3}{4}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{3}{4}$	$2\frac{1}{4}$
53	$2\frac{5}{8}$	$2\frac{31}{32}$	$1\frac{5}{8}$	$\frac{19}{32}$	$1\frac{1}{16}$	$\frac{27}{32}$	$4\frac{5}{8}$	$1\frac{17}{64}$	$\frac{5}{16}$	$\frac{19}{32}$	$1\frac{1}{2}$	$1\frac{1}{4}$	$4\frac{5}{8}$	$2\frac{21}{64}$	$7\frac{1}{8}$	$13\frac{1}{16}$	$3\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$1\frac{1}{2}$	$2\frac{15}{16}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$3\frac{1}{16}$
54	$2\frac{13}{16}$	$3\frac{9}{16}$	$2\frac{9}{16}$	$\frac{19}{32}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$4\frac{1}{4}$	$1\frac{13}{64}$	Flush	$\frac{19}{32}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$4\frac{1}{2}$	$2\frac{13}{32}$	$7\frac{7}{16}$	$13\frac{13}{16}$	$4\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$2\frac{1}{16}$	$3\frac{9}{16}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$3\frac{1}{16}$
55	$3\frac{1}{16}$	$4\frac{7}{16}$	$2\frac{1}{16}$	$\frac{19}{32}$	$1\frac{3}{8}$	$1\frac{1}{2}$	$4\frac{1}{4}$	$1\frac{13}{64}$	$\frac{15}{16}$	$\frac{19}{32}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$4\frac{1}{4}$	$2\frac{13}{32}$	$7\frac{1}{32}$	$13\frac{9}{32}$	$4\frac{3}{8}$	$1\frac{1}{2}$	$1\frac{5}{8}$	$2\frac{3}{16}$	$3\frac{9}{16}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$3\frac{1}{16}$
56	$4\frac{3}{8}$	$5\frac{1}{8}$	$2\frac{1}{4}$	$1\frac{3}{32}$	$1\frac{1}{4}$	$1\frac{15}{16}$	$5\frac{1}{4}$	$1\frac{25}{64}$	$\frac{1}{2}$	$1\frac{3}{32}$	$1\frac{13}{16}$	$1\frac{7}{16}$	$5\frac{1}{4}$	$2\frac{29}{64}$	10	$18\frac{13}{16}$	$5\frac{5}{8}$	$2\frac{1}{2}$	$2\frac{1}{8}$	3	$4\frac{5}{16}$	$2\frac{5}{16}$	$1\frac{3}{4}$	$2\frac{5}{16}$	$1\frac{5}{8}$	$4\frac{1}{16}$

evident that all tools must be so designed as to clear the work while the cylinder is being rotated. That is to say, the main tool-slide must be pulled back far enough to enable the longest tool to clear the work.

Calculating Speed of Work-spindles

The speed of the work-spindles obtainable by direct drive and through the back-gearing was given in the January, 1913, number of MACHINERY, but as it might be possible in some cases to secure more satisfactory speeds with gears having a different number of teeth than those given in the table, it may be advisable to carry through the calculations used in obtaining the proper gears to use for the required speeds. As was explained in a former article, the work-spindles are rotated from the main drive shaft through gearing. The gears on the main shaft drive the spindles through a friction gear that can be disconnected from the spindle when it is necessary to stop its rotation for performing operations such as threading, cross-drilling, milling, etc. As there are only two gears involved in this calculation, the method of obtaining the speeds of the spindle is simple and can be obtained from the following formula:

$$R = \frac{r \times N}{n}$$

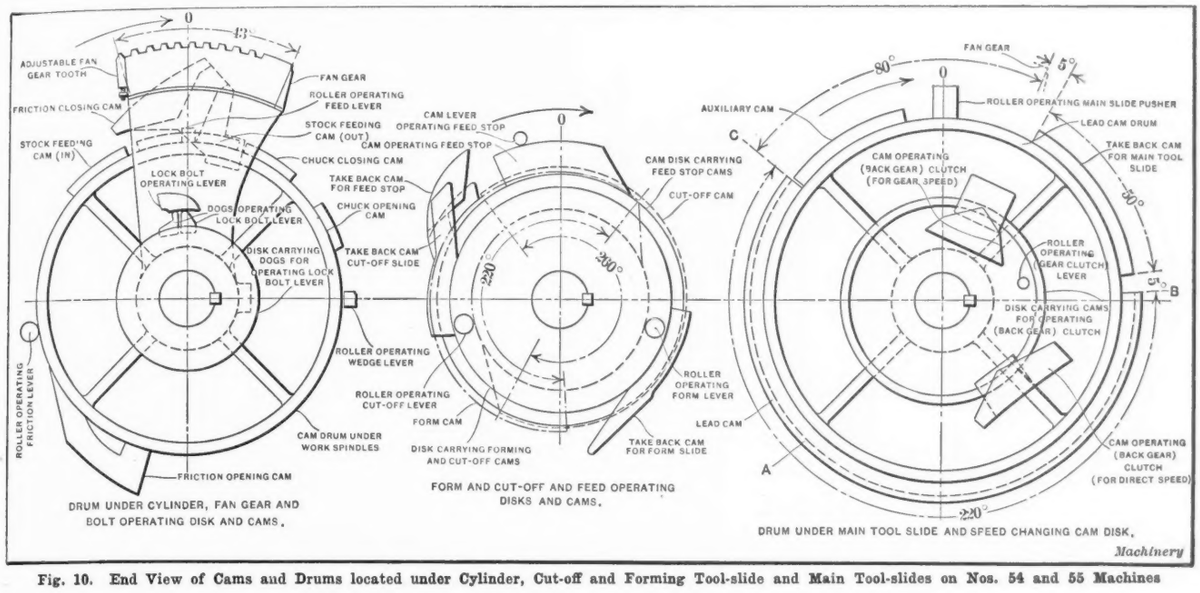

ADJUSTABLE FAN GEAR TOOTH
FAN GEAR
FRICTION CLOSING CAM
ROLLER OPERATING FEED LEVER
STOCK FEEDING CAM (OUT)
CAM LEVER OPERATING FEED STOP
CAM OPERATING FEED STOP
STOCK FEEDING CAM (IN)
CHUCK CLOSING CAM
LOCK BOLT OPERATING LEVER
TAKE BACK CAM FOR FEED STOP
DOGS OPERATING LOCK BOLT LEVER
CHUCK OPENING CAM
DISK CARRYING DOGS FOR OPERATING LOCK BOLT LEVER
TAKE BACK CAM CUT-OFF SLIDE
ROLLER OPERATING WEDGE LEVER
ROLLER OPERATING FRICTION LEVER
ROLLER OPERATING CUT-OFF LEVER
FORM CAM
CAM DRUM UNDER WORK SPINDLES
DISK CARRYING FORMING AND CUT-OFF CAMS
TAKE BACK CAM FOR FORM SLIDE
FRICTION OPENING CAM
DRUM UNDER CYLINDER, FAN GEAR AND BOLT OPERATING DISK AND CAMS.
FORM AND CUT-OFF AND FEED OPERATING DISKS AND CAMS.
CAM DISK CARRYING FEED STOP CAMS
CUT-OFF CAM
ROLLER OPERATING FORM LEVER
LEAD CAM
AUXILIARY CAM
FAN GEAR
ROLLER OPERATING MAIN SLIDE PUSHER
LEAD CAM DRUM
TAKE BACK CAM FOR MAIN TOOL SLIDE
CAM OPERATING (BACK GEAR) CLUTCH (FOR GEAR SPEED)
ROLLER OPERATING GEAR CLUTCH) LEVER
DISK CARRYING CAMS FOR OPERATING (BACK GEAR) CLUTCH
CAM OPERATING (BACK GEAR) CLUTCH (FOR DIRECT SPEED)
DRUM UNDER MAIN TOOL SLIDE AND SPEED CHANGING CAM DISK.
Machinery

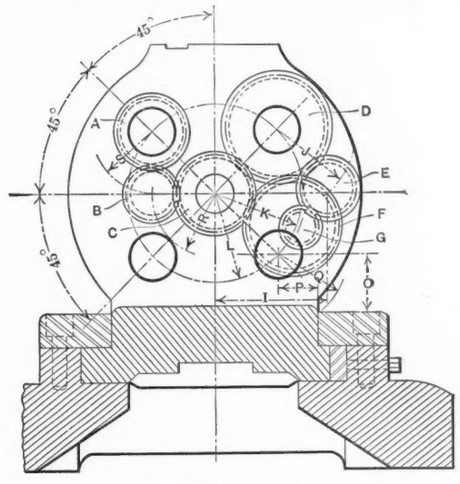
Fig. 10. End View of Cams and Drums located under Cylinder, Cut-off and Forming Tool-slide and Main Tool-slides on Nos. 54 and 55 Machines

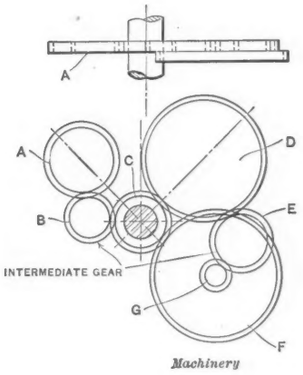
in which:

R = R. P. M. of work-spindles;
r = R. P. M. of top or main drive shaft;
N = number of teeth in gear on top or main drive shaft;
n = number of teeth in friction gear.

For example, on the No. 54 machine $R = \frac{35 \times 480}{45} = 373$

TABLE III. PRINCIPAL DIMENSIONS OF BACK GEARS AND CENTER DISTANCES OF TOOL-SPINDLES





Number of Machine	T = Number of Teeth Gears P = Diametral Pitch in Inches														Principal Dimensions in Inches								
	A		B		C		D		E		F		G										
	T	P	T	P	T	P	T	P	T	P	T	P	T	P	I	J	K	L	M	N	O	P	Q
51	24	16	17	16	24	16	34	16	17	16	34	16	18	16	$2\frac{3}{32}$	$1\frac{13}{16}$	$1\frac{13}{16}$	$1\frac{13}{16}$	$1\frac{1}{2}$	$\frac{49}{64}$	$1\frac{9}{32}$	$1\frac{9}{32}$	$1\frac{9}{32}$
515	22	12	16	12	20	12	34	12	16	12	36	12	14	12	$2\frac{3}{32}$	2.083	2.333	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{51}{64}$	$1\frac{15}{32}$	$1\frac{1}{2}$	1.583
52	24	12	18	12	22	12	38	12	18	12	40	12	16	12	$2\frac{3}{32}$	2.33	2.583	$2\frac{1}{2}$	$1\frac{1}{16}$	$\frac{53}{64}$	$1\frac{17}{32}$	1.666	$1\frac{3}{4}$
53	26	10	18	10	22	10	43	10	15	10	45	10	15	10	$3\frac{1}{32}$	2.90	3.35	$3\frac{1}{4}$	$2\frac{9}{32}$	$\frac{55}{64}$	$1\frac{7}{8}$	2	2.20
54	36	10	21	10	26	10	55	10	20	10	54	10	17	10	$4\frac{9}{16}$	$3\frac{3}{4}$	4	$4\frac{1}{64}$	$2\frac{27}{32}$	$1\frac{29}{32}$	$2\frac{9}{32}$	2.35	$2\frac{7}{8}$
55	36	10	21	10	26	10	55	10	20	10	54	10	17	10	$4\frac{9}{16}$	$3\frac{3}{4}$	4	$4\frac{1}{64}$	$2\frac{27}{32}$	$1\frac{29}{32}$	$2\frac{9}{32}$	2.35	$2\frac{7}{8}$
56	33	8	22	8	26	8	54	8	22	8	54	8	16	8	$5\frac{7}{16}$	$4\frac{1}{4}$	5	5	$3\frac{7}{16}$	$1\frac{7}{16}$	$3\frac{7}{32}$	3	$3\frac{7}{16}$

R. P. M., approximately. It might be mentioned here that in all future calculations particular reference will be made to the Nos. 54 and 55 machines, as these two sizes meet general commercial requirements. It might also be explained in regard to the tables that in all cases where the calculations for the gears do not work out to an even figure the nearest 5 or 0 is taken.

Calculating Speeds of Threading and "Second Position" Tool-spindles

A notable feature of the "Acme" multiple-spindle automatic screw machine is that, for threading, the work is stopped and the die is rotated, but in backing off the reverse is the case. In order to fulfill these requirements, it is necessary to gear up the threading-spindle to the main drive or top shaft. The diagram presented in connection with Table III shows the relation of the gears for rotating the threading-spindle and the spindle in the "second position." Two speeds for each speed of the top or main drive shaft are possible by shifting the gearing, one speed being obtained by driving direct through the sliding gear on the main drive shaft to the gear on the threading-spindle and the other by driving

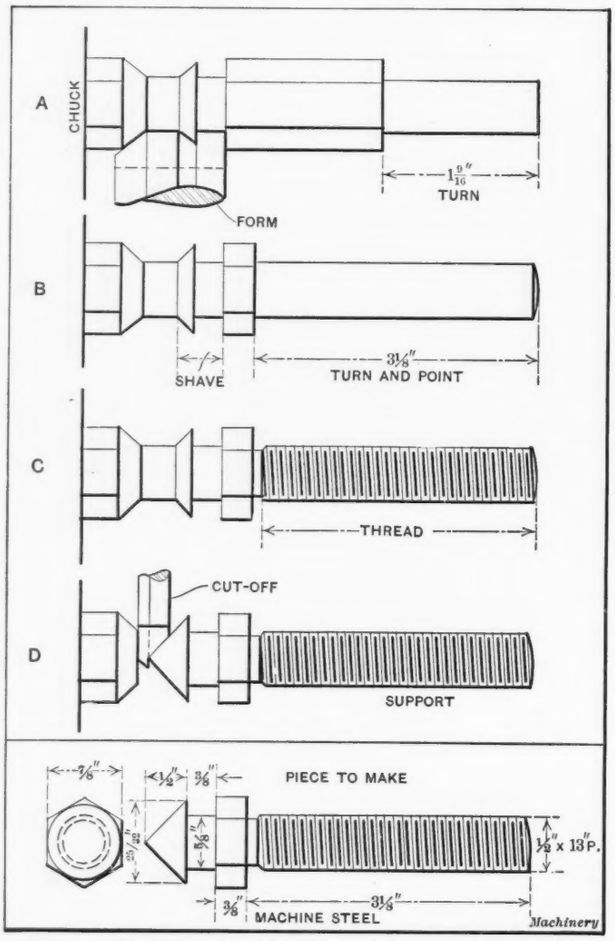


Fig. 11. Order of Operations followed in producing a Cone-headed Screw

through an intermediate and a compound gear. The following formula is used for obtaining the speed of the spindle when driven direct:

$$R_1 = \frac{r \times N_1}{t}$$

in which:

R_1 = R. P. M. of threading-spindle (direct drive);
r = R. P. M. of top or main drive shaft;
N_1 = number of teeth in sliding gear on top or main drive shaft;
t = number of teeth in gear on threading-spindle (also called direct gear).

As an example, assume that the speed of the top or main drive shaft is 480 R. P. M., then:

$$R_1 = \frac{480 \times 26}{55} = 227 \text{ R.P.M. approximately.}$$

(The numbers of teeth in these gears are listed in Table III.) The formula for obtaining the speed of the threading-spindle, when driven through the intermediate and compound gear, is as follows:

$$R_2 = \frac{r \times N_1 \times T}{n_1 \times t}$$

in which:

R_2 = R.P.M. of threading-spindle (gear driven);
r = R.P.M. of top or main drive shaft;

TABLE IV. TIME REQUIRED IN SECONDS TO PERFORM IDLE MOVEMENTS ON VARIOUS SIZES OF MACHINES

Number of Machine	Time in Seconds to complete Longest Single Operation	
	When Operation is performed from Main Tool or Form Slide	When Operation is performed from Cut-off Tool Slide
51	1.1	0.87
515	1.2	0.97
52	1.7	1.33
53	2.3	1.85
54	2.4	1.88
55	2.4	1.88
56	4.6	3.58

Machinery

N_1 = number of teeth in sliding gear on main drive shaft;
T = number of teeth in pinion gear;
n_1 = number of teeth in back-gear;
t = number of teeth in gear on threading-spindle (also called direct gear).

The "second position" tool-spindle which can be used for threading, if necessary, and which in many cases is used for driving small drills at their proper peripheral speeds, is also rotated from the top or main drive shaft through gears. The speed of this spindle can be obtained by the following formula:

$$R_3 = \frac{r \times N_1}{T_1}$$

in which:

R_3 = R.P.M. of "second position" tool-spindle;
r = R.P.M. of top or main drive shaft;
N_1 = number of teeth in sliding gear on main drive shaft;
T_1 = number of teeth in gear on "second position" tool-spindle.

For a practical example, assume that the speed of the main drive shaft is 480 R. P. M., then:

$$R_3 = \frac{480 \times 26}{36} = 346 \text{ R.P.M. approximately.}$$

Main Cam-shaft Computations

The main cam-shaft on the "Acme" automatic carries all the cams for operating the various slides, spindle stopping mechanism, etc., and also the fan gear for indexing the cylinder. As shown in Fig. 9, which is a developed plan view of the cam-shaft with the drums and cams on it, it will be seen that one revolution of this cam-shaft completes one cycle of the machine; that is, one revolution of the cam-shaft would mean the completion of one piece, or four revolutions the complete indexing of the cylinder. The rotation of the cam-shaft is not connected directly with the rotation of the work-spindles, but indirectly the cams on it govern the rate of travel of the tools on either the top- or side-working tool-slides, and also the end-working slide. It is therefore necessary to determine for each job the relation between the speed of the spindle and the speed of the cam-shaft in order to determine the production per hour, minutes or seconds.

The cam-shaft is driven from the main drive pulley through bevel gearing and a Johnson clutch. The clutch forms the connection between the direct drive and gear drive to the cam-shaft, so that it is possible to rotate the cam-shaft at a much higher speed for the idle movements than the speed at which it is operating when the tools are cutting. To obtain the speed of the cam-shaft in revolutions per minute, when

driven direct, we can use the first figures given in the first column of Table VI (see January number), as these will give the number of revolutions the cam-shaft makes in one hour. Dividing this speed—585—by 60, we find that the cam-shaft on the Nos. 54 and 55 machines makes 9.75 R.P.M. or 0.1625 revolution per second. As there are 360 degrees in a circle and as any point on the cam drum makes 0.1625 revolution per second, the number of degrees passed through in this time equals $0.1625 \times 360 = 58.5$ degrees, approximately. Now, if it takes one second for the cam-shaft to rotate through a space of 58.5 degrees, we can easily find the time required to complete the idle movements, when the number of degrees taken up by the idle or non-productive movements are obtained. By referring to Fig. 10, in which the various drums and cams have been laid out in their respective positions and at the point in their rotation at which the machine is indexing, we can see at a glance that the non-productive movements come in between the time that the lead cam *A* starts to operate and finishes. This applies when the longest single operation is performed by the end-working tools or from the forming slide. Where the longest operation is performed from the cutting-off slide, the idle time is less because there are 30 more degrees taken up on productive work. It is safe to

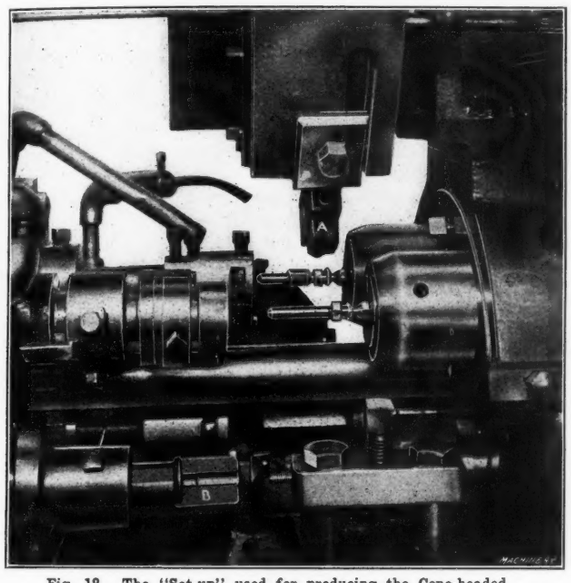


Fig. 12. The "Set-up" used for producing the Cone-headed Screw shown in Fig. 11

assume that on 75 per cent of the jobs set up on this machine the longest operation is performed from the end-working tool-slide; hence, we can base our calculations on the number of degrees of drum surface between the starting and finishing points of the cam. This we find is $360 - 220 = 140$ degrees. When the longest single operation is performed from the cut-off tool-slide, the idle movements occupy 110 degrees of the drum circumference.

Calculating the Time required for Idle Movements of Machine

The idle movements of the machine consist in advancing and withdrawing the tools to and from the work and indexing the cylinder. The stock is fed out and the chuck closed while the cylinder is indexing on the smaller machines and in the "first position" on the larger machines, but in all cases, as can be seen from a study of Fig. 10, the idle movements for which we have made provision more than compensate for the time required to feed out the stock. We therefore have three main idle or non-productive movements of the machine to take into consideration in calculating the actual time required. Upon referring to Fig. 10, we find that these movements are all confined to the space between *B* and *C* on the circumference of the cam drum. As all the non-productive movements are accomplished while the cam-shaft is being driven at its highest speed—direct through the Johnson clutch, and not through the chain gearing—it is necessary to find out what part of the cam circumference these movements occupy and also the speed at which the drum is being rotated when driven direct. We have just found that the idle movements or the space on the cam circumference from *B* to *C* equals 140 degrees, and that on the Nos. 54 and 55 machines the cam-shaft, when driven direct, is rotated at a speed of 0.1625 revolution per second. Then, if it takes one second for the cam-shaft to rotate through a space of 58.5 degrees, it will require $140 \div 58.5$ or 2.4 seconds approximately for the idle movements. This if added to the time required for the longest single operation will give the actual time required to complete one piece.

Example

In order to carry through the calculations which have just been given and to put them in such a form that they can be used in practice, it might be advisable to give an example. We will assume that it is necessary to make the cone-headed screw shown in Fig. 11, the tool "set-up" for which is shown in Fig. 12. The first point in the calculation is to determine the speed at which the spindle should be rotated for turning the material from which the screw is made, and also the longest single operation. This, of course, is the turning of the body. As a general rule, cold-rolled steel can be worked at a surface speed of from 90 to 120 feet per minute and the nearest speed on the No. 54 machine that we can use is 375 R. P. M. The distance that the first box-tool has to travel on the work is $1.562 + 0.038$ or 1.600 inch; then using a feed of 0.004 inch per revolution, we find that it requires 400 revolutions of the spindle to complete the first cut on the body of the screw. This is equivalent in time to 64 seconds.

Now, to obtain the time required for the idle movements, we calculate the time required for the cam-shaft to pass through 140 degrees, as was previously explained, and add the result to the time required for the longest single operation to obtain the time to make one piece. We found the time for the idle movements to be 2.4 seconds, so the total time required to complete one piece is $64 + 2.4$ or 66.4 seconds. Now to convert the time required to make one piece into production per hour, it is necessary to divide 3600 by 66.4, which gives a product of 54 pieces per hour. By referring to Table VI which appeared in the January number of MACHINERY, we find that the nearest product to the result of our calculations is 50 pieces per hour. As it is impossible to obtain a gear ratio to give the calculated product, it is necessary to do one of two things. First, if the box-tool performing the longest operation will stand a greater feed, we can raise the production up to 58.5 pieces per hour; if not, it will be necessary to drop down to 50 pieces per hour, and in so doing reduce the feed on the tools.

When the time required for the idle movements has once been calculated it is not necessary to go through this calculation again except in cases where special fixtures or tools are used that would necessarily require more than the usual clearance space, or where the lead cam is cut up to divide cuts, etc. As this is very infrequently the case, the actual time in seconds utilized in the performance of the idle movements is given in Table IV for the various sizes of machines.

As the various steps followed in setting up a job similar to the one illustrated in Fig. 12 on the "Acme" were described in the previous installment it will not be necessary to go into this subject here. This particular job differs only in two respects from the one previously referred to. Part of the head is finished by a shaving tool *A* and the work when being cut off is steadied by a support *B* to secure a good job. This support prevents the thrust of the cut-off tool from breaking the piece off before the cone-head has been completely formed with the cut-off tool.

Calculating Speed of Main Cam-shaft

The following formulas are used for calculating the speed of the cam-shaft when driven direct and when driven through the change gears. For direct speed:

$$R_4 = \frac{r_3 \times N_2}{n_2 \times W}$$

in which:

R_4 = R. P. M. of main cam-shaft;

r_3 = R. P. M. of clutch shaft;

N_2 = number of teeth in sprocket on clutch shaft;

n_2 = number of teeth in worm-gear sprocket;
W = number of teeth in worm-wheel on the cam-shaft.

For an example on the No. 54 machine, where the clutch shaft is rotated at 493 R.P.M., the result is as follows:

$$R_4 = \frac{493 \times 24}{16 \times 76} = 9.73 \text{ R.P.M.}$$

The formula for calculating the speed of the cam-shaft when driven through the change gearing is as follows:

$$R_5 = \frac{r_3 \times A \times D \times N_2}{C \times B \times n_2 \times W}$$

in which:

R_5 = R.P.M. of main drive shaft (gear driven);
r_3 = R.P.M. of clutch shaft;
B = first gear on clutch shaft (driven);
C = second gear on stud (driven);
N_2 = number of teeth in clutch shaft sprocket;
A = number of teeth in second gear on clutch shaft (driver);
D = number of teeth in first gear on stud (driver);
n_2 = number of teeth in worm-gear sprocket;
W = number of teeth in worm-wheel on cam-shaft.

With the aid of these formulas it is possible to calculate the production per minute or hour given in Tables II to VII in the January number of MACHINERY.

* * *

A FEW QUESTIONS ABOUT RING-OILING BEARINGS

BY A. DE SIGNER

One of the subjects about which there seems to be little reliable information in the way of results of actual tests, is concerning the ring-oiling bearing. Here are a few of the questions which arise in designing these bearings to suit certain conditions. What are the limits of speed at which it is safe to use this method of lubrication? It seems that there must be a high limit at which the oil would be thrown off the ring by centrifugal force before getting high enough to be deposited on the journal, or else the retarding effect of the oil in the reservoir into which the ring dips may slow it down so much, relative to the speed of the shaft, that it will not deliver enough oil to properly lubricate the journal. Then there must be a low limit at which the oil would run down the ring faster than the ring moves, and consequently too little oil would be delivered to the journal. It would not require very many experiments to arrive pretty accurately at these limiting speeds and the information might be very useful to the designer.

What is the best shape for the ring? I have seen rings of square and rectangular section, triangular section, half-round section and an inverted T-section made of two angles riveted together with the adjacent legs standing out from the journal. This last section is used by one of the largest engineering concerns in the country, yet I have known it to fail completely to deliver the necessary supply of oil. We replaced it by the rectangular section and had no further trouble. The triangular section was used on the outboard bearing of a direct-connected engine-generator running at moderate speed, which gave trouble by running hot from the very start. We replaced it by a ring of half-round section with very good results, the bearing running cool from that time on, with other conditions unchanged.

What is the best material for the rings? I have seen them made of cast iron, wrought iron and bronze, with apparently equal success. The cheapest rings I ever saw were made of half-round wrought iron in the rough, the only machine work being the joining of the halves and they were apparently very satisfactory. They were used on bearings from 2½ inches to 22½ inches diameter, with equally good results. My own opinion is that these were not only the cheapest but the best as well, because they could not be broken under ordinary running conditions, while I have seen broken rings of bronze. If made of good wrought iron, there is less danger of hard spots, which might cut the shaft, than there is with either bronze or cast iron. However, I don't think this a serious consideration, for there is little danger of any of them cutting a shaft. One of the very best rings I have seen was of rectangular section with the outer corners chamfered and was made of bronze. This ring was knurled on the inside, giving it the maximum driving power.

How many rings are needed for a given length of bearing? How far is it safe to figure on spreading the oil each side of the ring? To what extent does the diameter of the journal affect this point? It seems as if the area to be lubricated must have a considerable influence, and yet I cannot believe that the same area could be lubricated on a 2½-inch journal as on one 22½ inches in diameter. Of course, proper grooving must have a good deal to do with it, too.

What is the best grade of oil to use in a ring-oiling bearing? An oil that is too stiff might retard the ring to such an extent as to interfere with lubrication, while one that was too light might not be carried to the top of the journal and might be of insufficient body for lubrication. Where are these limits to be set? Other questions might be: the best depth to which the ring should be immersed in the oil; whether the diameter of ring (within reasonable limits) has any effect on its ability to deliver the oil; how much the ring swings to one side at different speeds. It is customary to allow rather a limited clearance for the ring in order to keep down the size of the bearing casing, but it is conceivable that the ring might rub against one side of the casing to such an extent as to interfere with its proper operation.

Another question which confronts the designer is: How large an oil reservoir is needed? In some bearings which I have seen, the object sought, apparently, has been to keep this down to a minimum, giving the bottom a cylindrical shape to conform with the shape of the ring, while others are made rectangular and have a capacity for a considerable quantity of oil. To my mind the latter is the right idea, since the oil will keep cooler and the flat bottom of the box allows quite a space for the collection of sediment before it will pile up sufficiently to retard the ring.

A little point which I have known to be overlooked is to provide a passage for the oil to flow from one end of the bearing to the other in the oil reservoir. With the ball and socket type this is not always easy, but I know from personal experience that it is advisable, having neglected it in some of my first designs, and had to connect the two reservoirs by a pipe afterward in order to prevent all the oil being carried to one end. Just why this action should take place, I do not see, but it certainly did.

It seems to me that most of the above questions might be systematically investigated to the advantage of the multitude of designers who are continually being called on to get out bearings for various duties. Why could not some of our colleges take this up and make systematic tests of different kinds of rings at different speeds and with different grades of oil? This is an investigation which would not require an expensive equipment and might furnish some very valuable data, and I commend it to the readers of MACHINERY in the hope that some of them may take it up. If such tests have already been made, I should be glad to see the results printed in these columns.

* * *

The New Britain Machine Co.'s plant in New Britain, Conn., built a year or two ago, is a four-story and basement building. The high price of land in New Britain made the factory type of building imperative. Plunger elevators are provided to serve the floors and an automatic system keeps the water pressure constant. The water is used over and over again, thus avoiding water waste and unnecessary expense. Employes use the elevators freely when going from floor to floor. Before the building of the new plant, they were not allowed to use the elevators because of the cost of power, attendance, etc. When making the plans, the management decided "that power generated in the power plant from coal is cheaper than that made from mince pie," and provided liberally for the substitution of mechanical power for human effort when travel vertically was necessary.

SOME MANUFACTURING KINKS USED ON CONTRACT WORK

WAYS AND MEANS USED IN MACHINING ADDING MACHINE PARTS AT W. H. NICHOLS CO.'S SHOP, WALTHAM, MASS.

BY CHESTER L. LUCAS*

In shops where contract work is done it is highly important that effective methods be used, thereby keeping the manufacturing costs down and leaving a margin of profit. The ways and means which must be devised for each job vary with the character of the work and the number of pieces

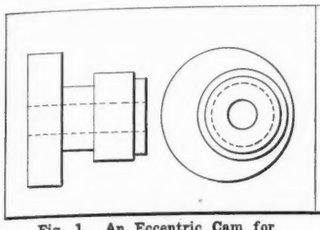


Fig. 1. An Eccentric Cam for Adding Machine Use

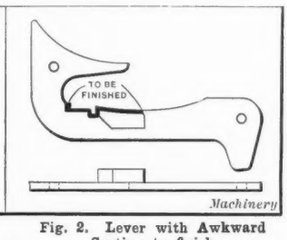


Fig. 2. Lever with Awkward Section to finish

required; therefore a great deal of ingenuity is required to get out tools which will produce the work without great expense or delay for initial equipment.

Oftentimes, the methods which must be used for producing the parts may not appear to be quite mechanical, but considering the small number of pieces which are required and the limited expense for tools permissible, the unmechanical way is often the more practical. An example of this point is well illustrated in the turning of the eccentric cam that is reproduced in Fig. 1. This is a steel part for an adding machine, and its greatest diameter is 1¼ inch. The length is 1⅛ inch. A ¼-inch hole passes through the piece, being located 3/16 inch off center, and with the exception of the eccentric part, the rest of the piece is concentric with this hole. As the shop equipment did not include a large turret lathe at that time, it was quite a problem to produce these pieces without installing an expensive turret lathe that would handle 2-inch bar stock. The method finally adopted was to use 1¼-inch cold-rolled bar steel, which was first cut to lengths of 2¼ inches. A round block of steel was then threaded to the spindle of an ordinary 14-inch lathe, and in the working end an eccentric hole was bored to a diameter of 1¼ inch and a depth of 1 inch, the eccentricity agreeing with that of the piece to be turned. The 2¼-inch central hole was drilled, and a cutting-off tool mounted on the cross-slide at the rear side of the work was set at the proper distance from the end of the piece to cut it off to the exact length when the cross-slide was withdrawn. Of course this method of doing the job resulted in a piece of stock one inch long being wasted for each piece made, but these ends were available for other work. In view of the number of pieces to be made, however, and the equipment at hand, it proved to be satisfactory.

Another little kink in turning which has helped in producing duplicate work is illustrated in Fig. 3. Many of the adding machine parts are roughed out on small screw machines and must be re-turned in bench lathes, usually being held on an arbor for the operation. In Fig. 3 is shown the method of locating the work in the lathe so that each piece will be gaged from the same point. The piece shown at *A* is held on an arbor *B* which, in turn, is held in the usual

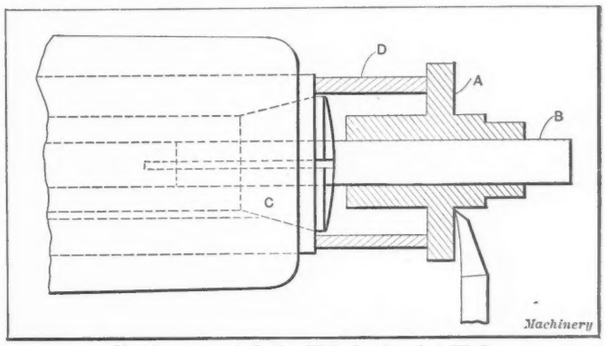


Fig. 3. A Bench Lathe Kink for locating Work

manner in the spring collet *C*. Before inserting the arbor in the collet a thin walled bushing *D* is introduced, which bears against the spindle of the lathe on one end and against the reverse side of a shoulder of the work at the other end. When the drawing-in bar of the lathe is tightened, it pulls the work firmly back against bushing *D*. As the turning tool has been set to perform the machining at an exact distance from the end of the bushing, the cuts must all be gaged

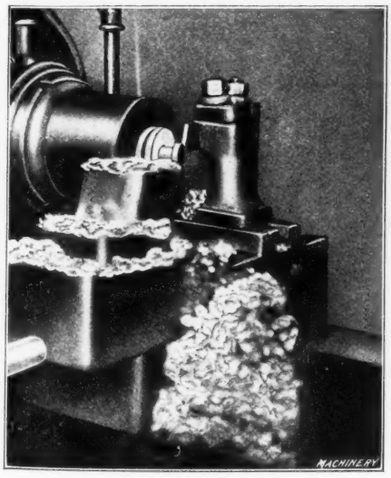


Fig. 4. Turning the Eccentric Cam in a 14-inch Lathe

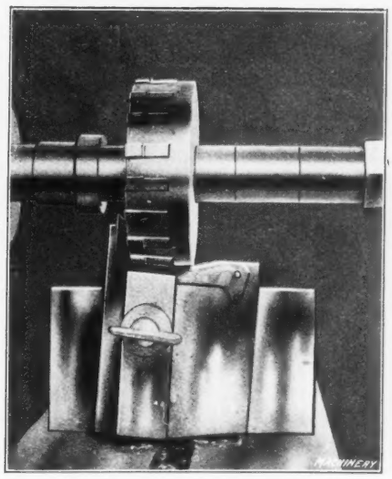


Fig. 5. Milling the Internal Section of a Computing Machine Lever

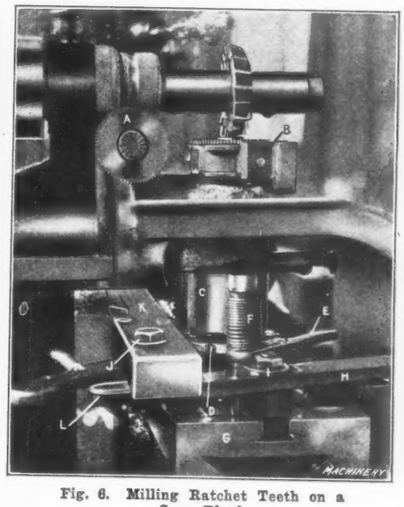


Fig. 6. Milling Ratchet Teeth on a Gear Blank

length of steel was then inserted in this improvised chuck and held by hollow set-screws. On the cross-slide of the lathe a forming tool was fitted that was shaped to turn down the entire width of the piece as shown in Fig. 4. Where the cross-slide was run in, this tool turned the stock down to the required size, leaving the original surface of the bar to form the eccentric part. By means of a drill in the tailstock, the from the face of the shoulder—that is, against the bushing. While comparatively unimportant, this is a good method to employ on bench lathe work of this kind.

A puzzling proposition was presented in the machining of a steel computing machine lever. The surface to be finished is indicated by the heavy line on the work shown in Fig. 2. This piece is a hook-shaped punching upon which has been riveted a small block. After riveting, it is necessary to mill

* Associate Editor of MACHINERY.

the section indicated true with the two holes in the punching. Of course the natural way to do the job would be to mill it, but trouble arises because of the shape of the punching which extends back over the surface to be milled. Broaching would do the work satisfactorily, but would be a little slow and would require expensive equipment. As is the case in most of these contract jobs, the number of pieces

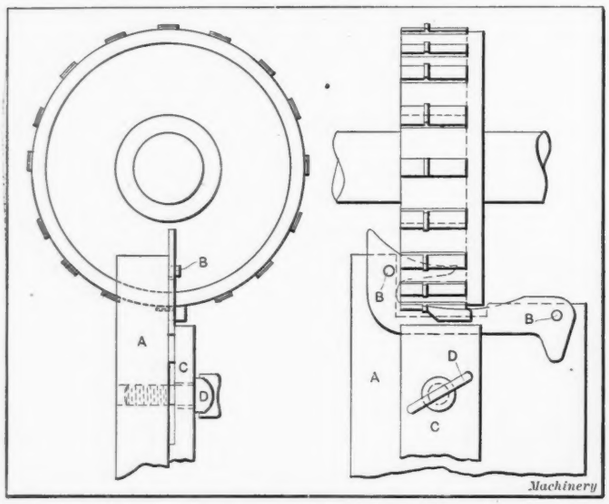


Fig. 7. Details of the Milling Fixture used in finishing the Computing Machine Lever

required was limited and it was doubtful if repeat orders would be called for; therefore it was necessary to devise a method requiring as inexpensive tools as possible. The method adopted involved the making of a special cutter which was recessed to clear the hook-shaped projection. The illustration Fig. 5 gives a general idea of the operation, and Fig. 7 shows the cutter and the method of holding the pieces. Obviously the pieces must be milled one at a time, because the interference of the cutter prevents a long table stroke.

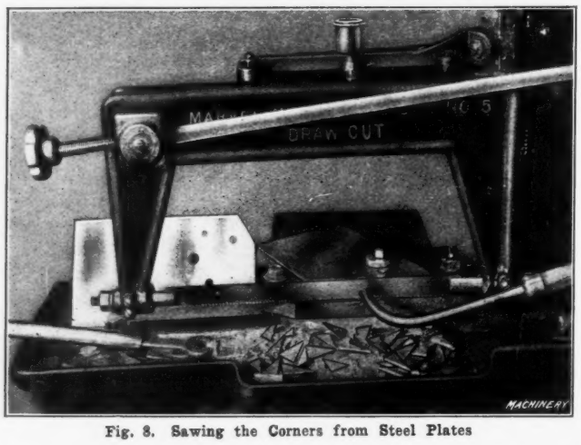


Fig. 8. Sawing the Corners from Steel Plates

The pieces are located on fixture *A* by means of two pins *B*, and are supported by clamp *C*, operated by thumbscrew *D*. The cutter is held upon an arbor in the usual manner. The work is hooked inside the cutter, set on the pins and clamped in place, and the milling cut started. The travel of the table is less than three-quarters of an inch, but it is enough to allow the surface to be milled properly. The piece is then removed and another blank inserted. It will be readily appreciated that the cost of tooling up for this job was not great, and the work produced was highly satisfactory.

Milling the ratchet teeth on the face of a gear blank, as shown at *A* in Fig. 6, is another machining operation that is handled very rapidly in this shop. The gears, as well as parts of adding machines, are turned with a raised panel around the central hole, and upon this panel ratchet teeth must be milled. The gears are located by means of three toothed blocks *B* which engage the teeth and hold the gear centrally upon the arbor *C*.

At the lower end of this arbor is an index-plate *D*, having equidistantly spaced notches; in this case there are fourteen. *A* pawl *E* engages this index-plate, and is mounted upon stud *F*, being kept constantly in contact with the index-plate by means of a spiral spring. The usual table feed mechanism is dispensed with and the table, which is indicated at *G*, is reciprocated by means of hand lever *H*, fulcrumed at bolt *I* attached to the T-slot of the table. The short end of the lever is slidably mounted on bolt *J* which passes through arm *K*, the latter being bolted to the frame of the machine. Also mounted on arm *K* is the indexing finger *L*, that, when brought into contact with the ratchet plate at each return stroke of the table, causes the arbor to turn one notch. The arbor is held stationary for the milling operation by pawl *E*. The milling of these ratchet teeth is performed as quickly as the operator can manipulate the lever, and after going once around the work a second cut is taken even more rapidly than the first, to remove any burrs and clean up the teeth.

Some excellent work is done on the "Marvel" draw-cut hacksaw and one of the sawing operations is shown in Fig. 8. This consists in sawing off the corners of steel plates ⅛ inch

Fig. 9. A Kink for holding Small Punchings on the Magnetic Chuck

thick, one of which is shown bolted onto a fixture on the farther side of the saw blade. Of course these corners could be clipped, but as one of the requisites is that the plate be perfectly straight and true when finished, sawing is considered the safer method of accomplishing this operation. The gear blanks, upon which the previously described ratchet cutting operation is performed, are cut from the bar on this

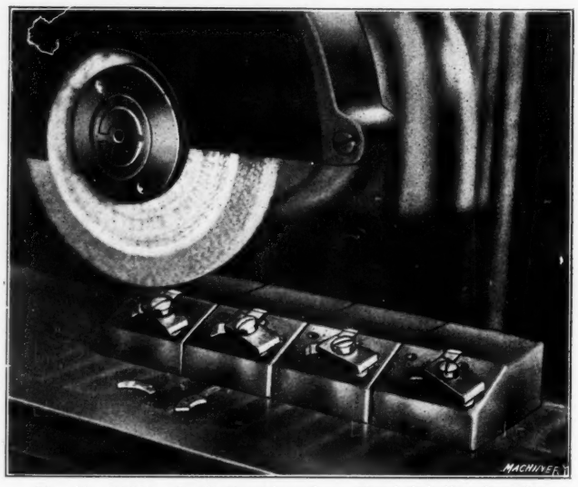


Fig. 10. Holding Small Punchings for a Bevel Grinding Operation

machine. A feature of its operation is that it automatically feeds the bar up after each cut and starts again, requiring no attention from the operator until the entire bar has been cut. The speed with which it works is extraordinary; on the gear blanks previously mentioned, which are 2¼ inches in diameter, the pieces drop from the saw every four minutes.

There are numerous surface grinding operations connected with the production of these adding machine parts, and Figs. 9 and 10 show two which are representative. In Fig. 9 a method of holding small irregular pieces on the magnetic chuck is worthy of note. These pieces are punchings made from ⅛-inch steel. They are held upon the magnetic chuck in strips which have punched holes of the same shape as the blanks. These strips are made from thinner stock than the steel punchings and the same blanking die is used. Afterward the openings are relieved by filing and allowing the blanks to fit in loosely. This is a very effective way of holding these parts, and has the advantage of being quickly provided.

Fig. 10 shows a grinding operation on the ends of the same pieces. These are beveled on each end at an angle of thirty degrees and the grinding is done after the pieces are clamped onto the inclined blocks shown on the chuck in the illustration. The pieces are located on pins and each is clamped in place by a single screw. Two finished parts may be seen lying in front of the blocks on the chuck.

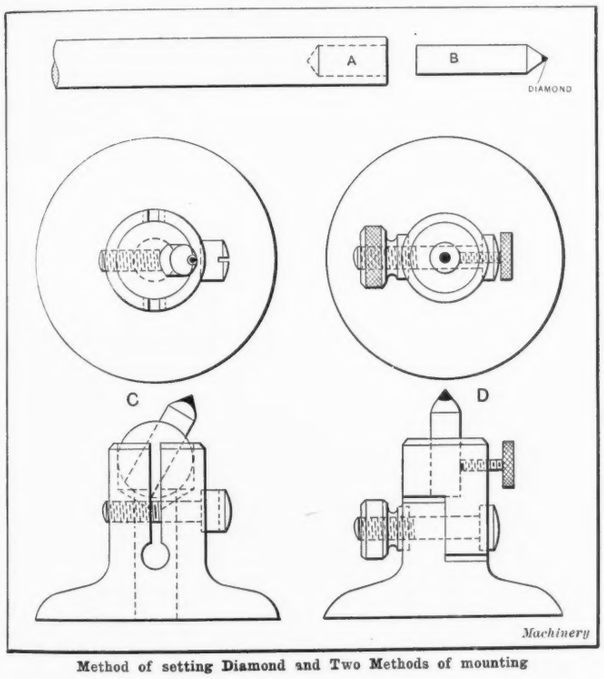
* * *

MOUNTING AND SETTING DIAMONDS

BY W. C. BETZ*

I have worked in a number of shops where a great deal of fine grinding was done, necessitating the use of diamonds for truing the wheels. C. L. L.'s article on the subject in the July issue of MACHINERY gave one good method of setting diamonds, but the writer would like to add the result of his experience in this work for the benefit of MACHINERY'S readers.

To reset a dull stone, the first step is to remove it from the holder which is drilled and reamed (as shown at *A* in the accompanying illustration) to the proper size to receive a piece of copper rod *B* in which the diamond is set. The diamond is then gaged through an ordinary twist drill gage, the stone being passed through a hole in which it just clears at the point where it is mounted in the holder. If a new diamond is used the holder is drilled as previously described; the copper rod in which the diamond is mounted is then chucked in a lathe and drilled to receive the diamond, the drill being of the size determined by gaging the diamond in a drill gage. The hole is drilled to a depth of 1¼ times the length of the stone, after which the copper rod is thoroughly annealed.



Method of setting Diamond and Two Methods of mounting

A small asbestos pad is next prepared from fiber secured from a piece of sheet asbestos, this fiber being moistened with saliva to enable it to be worked up into a small ball. This ball is made of such size that it half fills the hole in the copper rod when pushed down into place. The diamond is now put in position in the copper rod, after which the metal is upset around the edge with a light hammer in order to prevent the stone from coming out while the next operation is being performed. While this work is being done the copper rod is held in a three-jaw lathe or miller chuck held in a bench vise. After the metal has been upset around the diamond, the copper rod is removed from the chuck and the metal worked in close against the diamond with a light hammer. Some of the asbestos will be forced out of the end of the hole as the hammering progresses and care must be exercised not to strike heavy enough blows to risk crushing the diamond. The copper rod is then replaced in the chuck to enable the metal to be worked down close around the diamond with a hammer and a carpenter's nail-set ground off square at the end.

Now for a brief discussion of methods of mounting. An improved mounting for truing the wheel of a surface grinder while in the regular position is shown at *C*. This mounting consists of an ordinary commercial steel ball ¾ inch in diameter which is annealed to enable a 5/16-inch hole to be drilled and reamed through it. The stone is set in a copper rod 5/16 inch in diameter by 1 inch in length, the rod being a light driving fit in the hole in the ball. The base of the fixture is made either of cast iron or machine steel and it will be evident that the diamond can be brought into practically any position that is required by rotating the ball and then clamping it in place by means of the binding screw in the base. In this way the stone can be rotated from one position to another so that it is possible to bring a fresh edge into contact with the wheel as the diamond becomes dull. The form of holder shown at *D* possesses the same features which have been described for the preceding type of holder. In this case, the position of the diamond is changed by swinging the upper half of the holder about the pivot which secures it to the base. The diamond can also be rotated by loosening the small binding screw and then turning the copper rod in which the stone is mounted.

* * *

STROBOSCOPIC ACTION OF MOVING PICTURE MACHINES

A curious action of the wheels of rapidly moving vehicles is often noticed in moving pictures of street scenes. The wheels are apparently standing still or moving slowly forward or backward. The reason for this strange appearance of wheels that are actually revolving rapidly forward is coincidence or near coincidence of spoke position and shutter action. Suppose that a carriage wheel has sixteen spokes and that it is revolving at the rate of sixty turns a minute or once every second. The average speed of moving picture film exposure is sixteen pictures a second. Under such conditions the spokes apparently will be photographed in exactly the same position at every opening of the shutter, and when projected on the screen the wheel will appear to be standing still although moving ahead with the carriage. If the rate of rotation is slightly out of step with the shutter action the spokes will then be photographed in slightly different positions, and the wheel will appear to rotate slowly ahead or backward, depending on whether the shutter action is slower or faster than the change of spoke position. The action is essentially the same as that of the stroboscope, a well-known scientific apparatus used to study the action of rapidly moving mechanism, engine governors, etc.

* * *

YEARLY INDEX OF MACHINERY

The yearly index of MACHINERY is ready for distribution, and copies will be sent to any address on request. Subscribers saving their copies are urged to bind them with the yearly index and thus preserve the volume so that its contents can be readily referred to.

* Address: 127 Griswold St., New Britain, Conn.

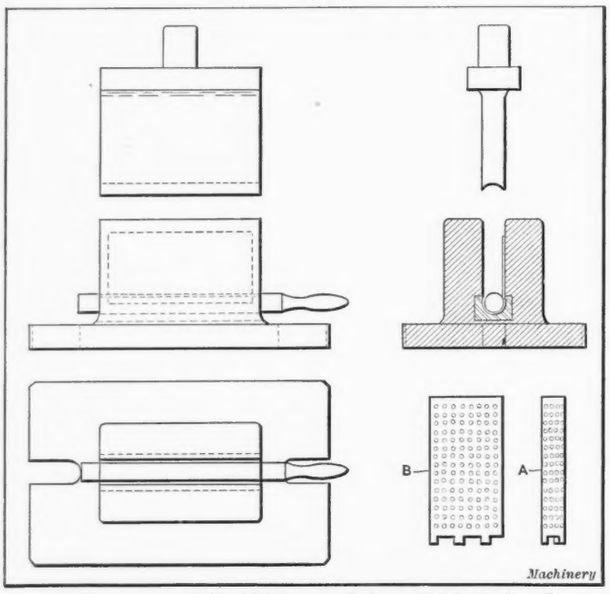
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

ROLLING TUBING FROM SHEET METAL

The accompanying illustration shows the tools used for rolling the perforated tubing *A*, the blank from which the tubing is rolled being illustrated at *B*. The design and method of using these tools will need little description to make the operation clear to the reader. The die was made with a tool-steel bottom inserted in a cast-iron frame to reduce its cost. The punch and die were finished to approximately the desired form, after which they were fitted together and the hole reamed to the required size of the tubing.

In operating the tool, the mandrel is placed in the die and



Tools used for making Tubing out of Sheet Metal—Blank and Finished Tube

a blank put in the position shown in the cross-sectional view. When the press is tripped, the punch descends and forces the blank down in such a way that it is rolled around the mandrel. When the ram has reached the bottom of its stroke, the pressure applied sets the joint so that the tube retains the desired form.

Meriden, Conn. JAMES GALLIMORE

WHY UPPER FORGING DIES FILL BETTER THAN LOWER ONES

The question was asked in the April number of MACHINERY "Why are the impressions for bosses on drop-forgings preferably put in the upper die?" The reason suggested in the answer that inertia of the metal is more active in filling the upper die than in filling the lower die is not, in my opinion, correct. The reason the upper die fills with metal more easily and quickly than the lower die is that when the forging blank or bar is laid on or placed in the lower impression the lower die immediately begins to withdraw the heat from the piece to be forged. Consequently, the metal on the lower side of the forging is several degrees cooler than that on the upper part and at every stroke of the hammer the forging fits closer to the shape of the die, cooling with every stroke, thus retarding the downward flow of the metal. On the other hand, the metal on top is always hottest as the die, coming down and instantly rising again, leaves the metal about as hot as before it was struck. Thus the metal obeys one of the great laws of nature—it "follows the line of least resistance" and shoots up and fills the upper impressions easily. This has been our experience in the Union Forging Co.

C. F. BRAINERD,
Union, N. Y. Supt. Union Forging Co.

[The cooling effect of the lower die undoubtedly retards the filling of deep impressions. This is proved by the fact that if the piece being forged is lifted from the lower die after each stroke, the lower die will fill more rapidly and effectively than if it is allowed to remain closely in contact with the die. This is well understood by drop-forgers generally. Another very practical reason for placing deep impressions in the upper dies when possible is that it eliminates trouble from scale. Deep impressions in lower dies are very troublesome because of the scale collecting in them. If the scale is not swept out it quickly ruins the dies, causing them to crack, and produces a rough finish on the forging.—EDITOR.]

ETCHING RESIST AND SOLUTION

The following gives a formula which has been successfully used by the writer for etching operations:

The ground or "resist" is compounded as follows: Melt 2 ounces of white wax and add to it 1 ounce of gum mastic in powder, the gum mastic being added a little at a time and stirred thoroughly so that a uniform mixture is obtained. Then add 1 ounce of bitumen powder in the same way. This mixture is dissolved in chloroform or oil of lavender, when it is ready for use.

The formula for the biting solution is as follows:

Hydrochloric acid .....100 grams
Chlorate of Potash ..... 20 grams
Water .....880 grams

In compounding the biting solution the water is heated, after which the chlorate of potash is added. After the chlorate of potash is entirely dissolved the hydrochloric acid is added to the solution.

H. N. HAMMOND
Erie, Pa.

METHOD OF ETCHING BRASS

In the "How and Why" department of the August number of MACHINERY, I note that M. R. states that he has experienced trouble in etching brass and asks for information regarding a satisfactory method. If M. R. will follow the instructions given below, I think he will find the result entirely satisfactory.

The first step in etching is to see that the parts that are to be etched are carefully ground and polished. The only cleaning which will be found necessary can be satisfactorily done by wiping the work with a dry rag. The next step is to heat the work and then dip it into molten paraffine, after which it is removed and allowed to stand until cool. The pattern which is to be etched is marked in the paraffine in order to expose the metal.

The etching is done with undiluted nitric acid. If the etched lines are to be very deep, the work should be immersed in lukewarm water occasionally to remove the copper nitrate which forms in the etched lines. This will prevent the lines from spreading. It is only necessary to leave the work under water for a few seconds in order to remove the copper nitrate.

The preceding instructions also apply to etching steel with the important exception that the etching solution is composed of one part of nitric acid and one part of hydrochloric acid. The paraffine may be removed from the work by first dipping it in boiling water and then in cold water; this treatment causes the paraffine to contract and peel off.

East Orange, N. J. GEORGE GARRISON

ETCHING STEEL AND BRASS

In response to the request in the August number of MACHINERY for reliable methods of etching brass, I will describe my method of etching which has been successfully employed on all kinds of machinist's tools, also on brass and watch cases. First I heat the article slightly, making it just

warm enough to melt the beeswax with which the article is coated, care being taken to make the coating very thin and to apply it evenly. After the wax has cooled, I mark the design or name in it with a hard pencil having a very thin, sharp point. The design or letters are cut through the wax down to the surface of the metal and care should be taken to have the marking cleanly done so that no wax is left where the design is to be etched. The etching is done with a solution consisting of six parts of nitric acid and one part of muriatic acid. I use a glass medicine dropper to apply the solution, covering the design to be etched with the acid. After allowing the acid to etch about five minutes, it is removed with a piece of cotton waste, care being taken to soak up all the acid that can be removed. Then the wax is scraped off and the surface is cleaned with a piece of waste soaked in lard oil. The result will be a nice clean etching.

Of course, like everything else, etching requires some practice in order to insure a good job. I generally brush the surface of the article with lard oil where there is no beeswax. The oil prevents the fumes of the acid from penetrating the surface and the acid from adhering to the parts if it is inadvertently dropped on them. To etch brass requires from ten to fifteen minutes for the solution to bite.

I have etched levels, scissors, indicators, surface gages, scales, etc., for the company I work for with good results, using the method described in the foregoing. Etching tools is far better than stamping them with a steel stamp. A steel stamp will almost invariably damage the tool, whereas etching will not. In this connection I might say that I have known men to pay from 50 cents to $1 for an etching kit which was of little use for the purpose intended. Ten cents worth of the solution given above and five cents worth of beeswax is sufficient to etch one hundred or more names on tools and other articles.

Pearl River, N. Y. WALTER BUTZ

MAKING ECCENTRIC SCREWS ON AN AUTOMATIC SCREW MACHINE

In the following article, the writer wishes to describe a simple fixture used with great success on the Cleveland auto

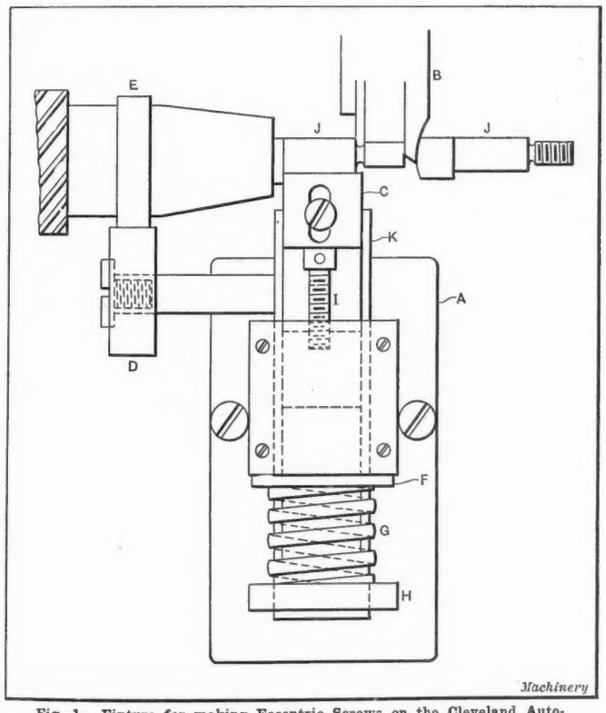


Fig. 1. Fixture for making Eccentric Screws on the Cleveland Automatic Screw Machine

matic screw machine in the manufacture of eccentric screws. Referring to Fig. 1, *A* is the fixture used to form the eccentric shoulder *J*, while at *B* a combination cut-off and form tool is shown which is used to sever the finished screw from the bar stock, and to form the small shoulder to be threaded on the next screw.

Before proceeding further, it should be mentioned that the chuck used on this job is central; thus it is understood that the threaded shoulder and the head of this screw are central, but the formed shoulder *J* is eccentric. The forming of the eccentric is accomplished by the form cutter *C* held in the fixture *A*, and adjustable by means of the screw *I*. An eccentric ring *E* is pressed over the spindle nose, as shown, and as the roller *D* is brought to bear against *E* by advancing the fixture to the work, the rotation of *E* causes the cutter *C* to form the eccentric portion of the screw as desired.

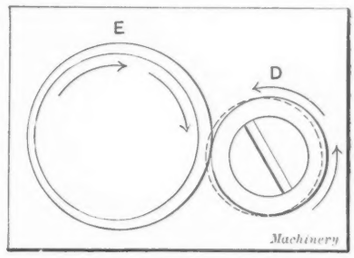


Fig. 2. Diagram showing Relation of Cam E and Roller D

A pin is shown at *F* fastened in the tool-slide *K*, which causes a compression of the spring *G* against the block *H*, serving to return the cutter *C* to the work when the small diameter of *E* is in contact with *D*. Thus it is understood

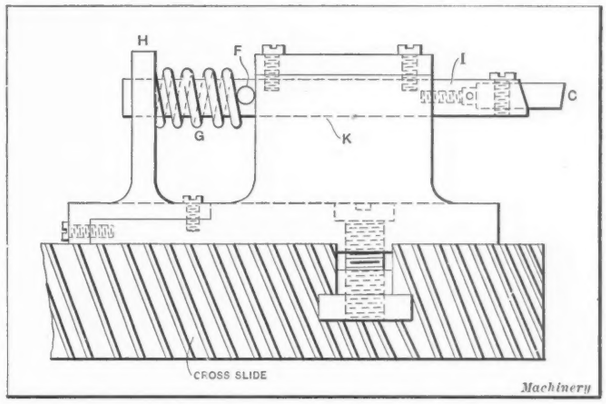


Fig. 3. Side View of the Eccentric Screw-making Fixture

that the forming of the work by the cutter is controlled by the relation of *D* and *E*, until the set-screw on the cross-slide stops further cutting and the fixture is tripped away to allow threading the small shoulder. Fig. 3 shows a side view of the fixture and Fig. 2 illustrates the relation of *D* and *E* to each other.

O. GORDON

CLUTCH DESIGN

The writer read Mr. J. W. Brassington's article on clutches in the August issue of MACHINERY and desires to comment on this interesting subject, not from the standpoint of an authority on clutch design but rather as an interested observer. In deriving formulas for the proper relative capacities of clutches, it appears that J. W. B. has failed in an important but seriously neglected point regarding the work done by a clutch, *i. e.*, the proper analysis of what constitutes the load. Taking the example cited by J. W. B. of a load of 10,000 pounds started from rest and accelerated to a velocity of one foot per second in one case, and to a velocity of three feet per second in another case, he arrives at the conclusion that a clutch of nine times the capacity of the one required in the first case is necessary in the second case.

The statement is then made that most clutch manufacturers would recommend a clutch of one-third the size required in the first case for the second case, owing to the higher speed. Assuming that loaded to 10,000 pounds means the tangential load or resistance at the periphery of the clutch—which it may be remarked is very much higher than the tangential load of any clutch that has come to the writer's notice—acceleration to a velocity of one foot per second makes the load $10,000 \times 60 = 600,000$ foot-pounds per minute.

$\frac{600,000}{33,000} = 18$ horsepower (approximately). In the second case the speed is accelerated to 3 feet per second and it is thus obvious that the clutch is doing three times the number of foot-pounds of work in the same period of time, *i. e.*, 1,800,000 foot-pounds per minute or 54 horsepower. Now does it not seem rather unlikely that a lighter clutch would be recommended by a manufacturer for use in the latter case? Had the horsepower remained 18 and the speed been increased three times, then the torque would have fallen to 1/3 of 10,000 pounds and a much lighter clutch could have been used. Here is where the writer believes that many "get lost" on the speed proposition, but it is clearly explained by the somewhat antiquated theroem of the three constituents of work, *i. e.*, time, space and weight or resistance in pounds.

Regarding the question of the pick-up capacity of a clutch, it has always appeared to the writer that the starting resistance was not particularly destructive to the mechanism unless the leverages of the clutch were such that it "seized" suddenly. Automobile designers have decided that such a seizing action is only likely to occur when the angle of a cone clutch is less than 12 degrees or its equivalent on a clutch of the toggle type. In an improperly designed clutch where such an action can occur, the mechanism is not only subjected to a violent shock but the torque is also increased due to inertia. Aside from this consideration, the only difference which the writer has observed in the behavior of a clutch while starting or when under way is that the coefficient of friction of rest is somewhat higher than the coefficient of friction of motion, the stresses being somewhat greater in the former case.

In conclusion, it may be stated that the writer has obtained satisfactory results with friction clutches designed according to these principles, and that he has designed at least one clutch which all of the shop men were prepared to wager was too small for the load it had to carry. After this clutch had been placed in service, it was found to be quite satisfactory and afforded a surprise to the men in the shop who did not have a "speaking acquaintance" with our friends "time," "space" and "weight."

Cleveland, Ohio. J. E. McMahon

MACHINE TOOL COUNTERSHAFT

On large hand screw machines much time is lost because the belt from the countershaft to the cone pulley of the spindle cannot be shifted from one step to another. If it could be shifted quickly, the production of machines engaged on many classes of work might be considerably increased

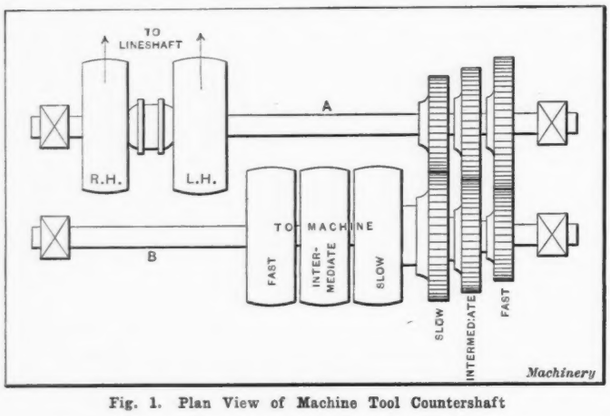


Fig. 1. Plan View of Machine Tool Countershaft

since some tools in the turret can be operated at a much higher surface speed than others. It is obvious that the speed of the spindle is limited by the speed that is suitable for the slowest tool in the turret.

The illustrations presented herewith show a countershaft which might be used to advantage in overcoming the difficulty referred to. It consists of two shafts *A* and *B* supported by double shaft hangers. The shaft *A* carries the regulation right- and left-hand pulleys with belts running to the lineshaft. This shaft also carries three gears (or chain drives as a substitute) which mesh with corresponding gears on the shaft *B*. Two of the gears on the shaft *B* are mounted on sleeves which run on rollers and have pulleys mounted on their opposite ends. The third gear is keyed direct to the shaft *B* and drives a pulley keyed to this shaft. A drum is mounted on the spindle of the machine in place of a cone pulley and the belt which drives the spindle runs from one of the pulleys on shaft *B* to this drum. As the belt can readily be shifted onto either of the pulleys on the counter-

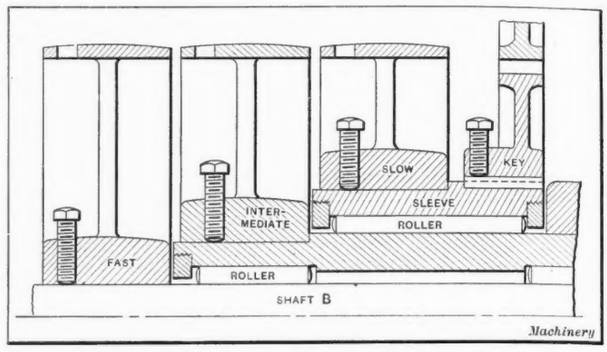


Fig. 2. Sectional View of Machine Tool Countershaft

shaft three speeds are provided for the spindle, which are in proportion to the ratios of the gears through which the pulleys are driven. The relative difference between the speed of adjacent pulleys is not great, so that the wear on the rollers and sleeves is reduced to a minimum.

The pulleys are crowned in the usual way and made about fifty per cent wider than standard pulleys for the width of belt which is used. The belt is moved by the usual form of shifter and the additional width of the pulleys enables it to get off the crown of one pulley before it goes onto the crown of the adjacent pulley. When the belt is shifted, the speed is gradually slowed down, or increased as the case may be, and as the belt is not on the crown of two pulleys at the same time it follows that the slippage and wear is reduced to a minimum.

Chicago, Ill. R. W. Ullmann

SIMPLE RULES FOR OBTAINING GEAR DIAMETERS

The rule of adding 2 to the number of teeth required on a gear, and dividing by the diametral pitch to obtain the outside diameter of a spur gear blank, is probably known to all mechanical draftsmen. There are two equally simple rules for obtaining the diameters of the circles representing the working depth of the teeth and their root diameters.

For the diameter of the circle representing the working depth of the teeth, subtract 2 from the number of teeth in the gear and divide by the diametral pitch; the result is the required diameter.

For the diameter of the root circle, subtract 2.314 from the number of teeth and divide by the diametral pitch; the result is the required diameter.

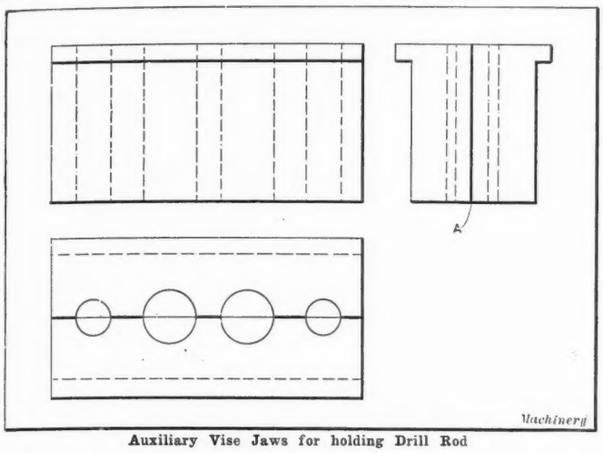
As an example, suppose a gear has 48 teeth and is of 4 diametral pitch; then $\frac{48+2}{4} = \frac{50}{4} = 12\frac{1}{2}$ inches outside diameter of the gear blank. And $\frac{48-2}{4} = \frac{46}{4} = 11\frac{1}{2}$ inches, diameter of circle representing the working depth of the teeth. $\frac{48-2.314}{4} = \frac{45.686}{4} = 11.4215$ inches, diameter of circle representing the bottoms of the tooth spaces.

Having never seen these rules in print, it occurred to the writer that they might be good enough to pass along to other draftsmen.

Los Angeles, Cal. John A. Wood

VISE ATTACHMENT FOR HOLDING DRILL ROD

A practical and very effective vise attachment for holding drill rod for cutting or finishing the ends is shown in the accompanying illustration. In order to make a vise of this kind, two pieces of machine or cold-rolled steel are planed to produce a shoulder ⅛ inch wide and ⅛ inch deep. The two parts of the vise are then placed together with a shim *A* about 0.010 inch in thickness between them as shown in the end view. They are then clamped in this position and the required number of holes to receive the standard sizes of drill rod for which the vise is to be used are drilled and



Auxiliary Vise Jaws for holding Drill Rod

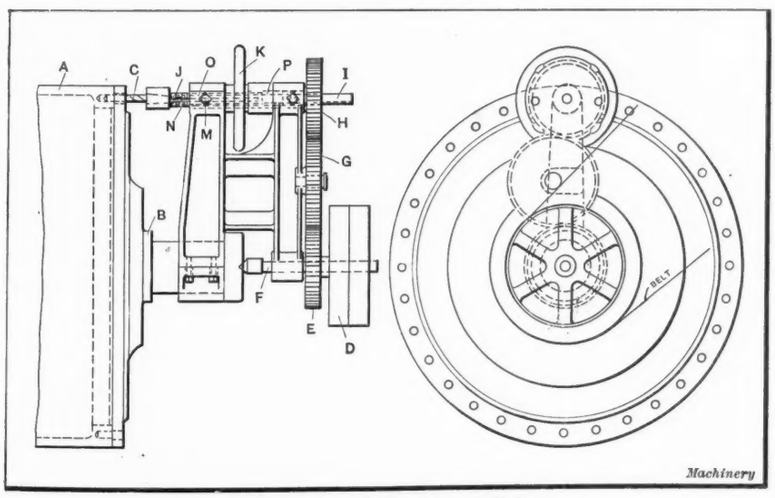
reamed. An allowance of ¼ inch is made at either end and from ⅛ to 3/16 inch between the holes for adjacent pieces of drill rod to provide the necessary wall strength.

The vise jaws are now ready to use. They are placed in an ordinary bench vise or the vise of a milling machine and the shoulders hold them in place. The removal of the shim *A* allows the jaws to come closer together than the position in which they were machined, and consequently a very firm grip is secured on any size of drill rod for which the jaws are intended. When a large number of pieces of round stock are to be slotted in a miller, this is a very cheap and practical device and its use enables drill rod to be securely held without marring its surface in any way.

Union Hill, N. J. G. J. JOHNSON

FIXTURE FOR DRILLING LARGE CYLINDERS

Some time ago we had quite a large number of cast-iron cylinders to machine, the heads of which were fastened in



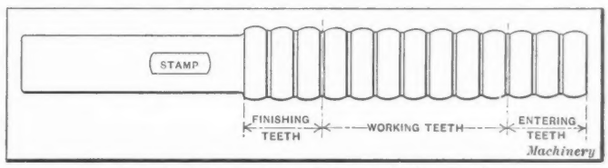
Fixture used for drilling Large Cylinders

place by thirty-two ¾-inch cap-screws. The heads were easily drilled on a drill press, but we were "up against it" when it came to the cylinders. As this work was somewhat out of our regular line, we did not feel inclined to buy any new and expensive machinery for the purpose, and so it became necessary to do the work as best we could. The accompanying illustration shows a simple fixture that we made for handling this work, in which *A* is the cylinder to be drilled and *B* the cylinder head. After the head had been drilled, and two holes had been drilled and tapped in the cylinder with a ratchet drill, the cylinder head served as a jig for locating the remaining holes. The fixture was fastened to the journal of the cylinder head and could be swung about this center to bring the drill *C* into any position on the periphery of the cylinder. The drill was secured in a socket at the end of the shaft *I* which was driven by the tight pulley *D* through gears *E*, *G* and *H*. The tight and loose pulleys and gear *E* are mounted on the shaft *F*. It will be seen that the spindle *I* is partly enclosed by a bushing *J* which can be moved longitudinally along the spindle by means of the handwheel *K*, but is prevented from rotating by the set-screw *M* which fits in the slot *N*. The parts *O* and *P* form two oil chambers which were kept full of oil at all times. This fixture was quite inexpensive to make, and as we used gears from a lathe and took the pulleys from a pump that we had on hand, it will be evident that it was unnecessary to machine any expensive parts. The use of this fixture enabled two unskilled men to drill one end of a cylinder in one hour and fifteen minutes, and the design insured having the holes drilled perfectly straight.

Sherbrooke, Quebec, Canada. OLAF MELBY

SMOOTH TOOTH BROACH

The illustration shows a broach of novel design which has the teeth rounded at the top instead of being finished to a cutting edge as in the ordinary type of broach. These teeth are highly polished, and experience has shown that the higher the degree to which this polish is brought, the better will



Smooth Toothed Broach used for machining Bearings

be the results obtained with the tool. It will be seen that the first few teeth are small enough to enter the hole which is to be broached, the intermediate teeth are of slightly larger diameter, and the last three teeth are of the size to which it is desired to finish the work.

This tool is used for broaching bearings and for operations on other classes of work where the metal is relatively soft, the tool compressing the metal, and thus giving it a surface hardness. This is of particular value in the case of bearings, on which class of work this broach has found wide application. The amount of metal displaced by the broaching operation is about the same as that removed by reaming, depending largely on the class of metal, lubrication and the construction of the broach. Although the tool is primarily intended for operations on babbitt and white bearing metal, it has been used satisfactorily for producing glazed surface on cast-iron bearings.

The distance from center to center of the teeth depends somewhat on the length of the work which is to be broached. It is desirable to have at least six or eight teeth working at all times. This broach is usually made according to the design shown in the accompanying illustration and is pushed through the work instead of being pulled in the ordinary way. An arbor or screw press may be used for this purpose and it is generally advisable to apply lubricant to the broach while in operation.

Hartford, Conn. S. VICTOR BROOK

[The noteworthy feature of the operation of a broach of the type described in the preceding, as compared with an ordinary plug, lies in the reduction of friction. It will be evident that the teeth of this broach are fully as efficient as a plug for handling the class of work for which the tool is intended. At the same time, the area of the tool in contact with the work is greatly reduced, with a corresponding reduction of friction and the amount of power required to drive the tool. The provision of teeth also makes it possible to apply lubricant to the work, which could not be done if an ordinary plug were used.—EDITOR.]

REDUCING FLATS ON HOBBED WORM-WHEEL TEETH

The larger the diameter of a hobbed gear—the pitch remaining the same—the more closely the tooth outline approaches the shape of a rack tooth. The flats left on the teeth by the hobbing operation also become perceptibly less as the size of

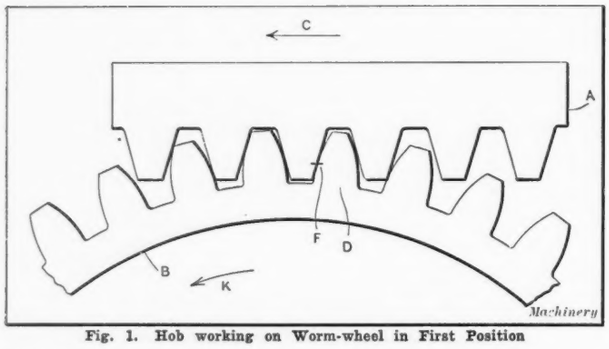


Fig. 1. Hob working on Worm-wheel in First Position

the wheel increases. The flats on the teeth of hobbed worm-wheels with a small number of teeth can be reduced by the use of a hob having a large number of flutes. Where a fly cutter hob is used, the flats can be further reduced by moving the hob along its axis after the first cut has been taken and moving the worm-wheel on its arbor a corresponding amount. By making five or six such shifts of the hob, a very smooth worm-wheel is produced. The fly cutter hob and gear blank must be geared together and the blank cut to depth before shifting the hob on its axis as previously described.

In Fig. 1, the tooth *D* of gear *B* is in contact with the hob *A* at the point *F*. In this position, a series of flats are produced on the gear as it revolves in the direction indicated by arrow *K*. By moving the hob along its axis a distance equal to a small fraction of the circular pitch in the direction

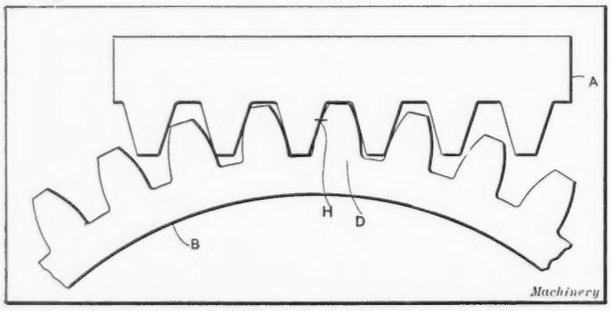


Fig. 2. Conditions after Hob has been shifted, showing Change in Relative Position of Hob and Work

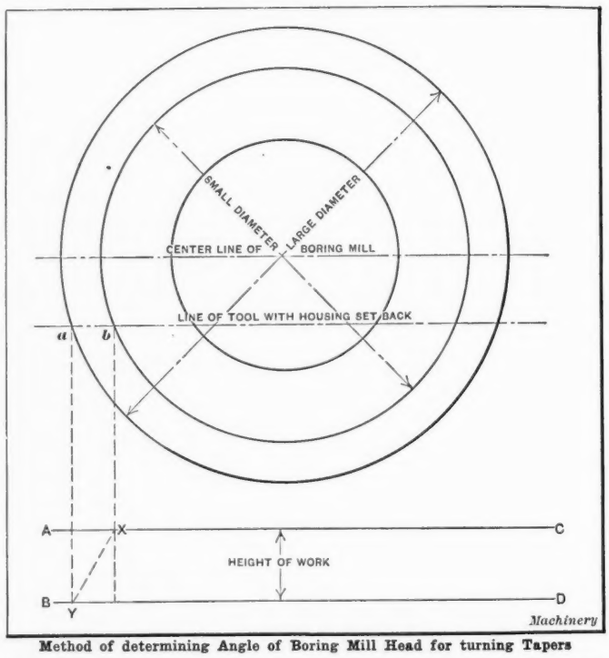
shown by the arrow *C*, the hob *A* is brought into contact with the tooth *D* at the point *H* as indicated in Fig. 2. A new series of flats is produced in this way causing the corners to be sheared off the flats which were produced when the hob was in the position illustrated in Fig. 1. By repeating this process, moving the hob along its axis a number of times, the flats produced in hobbing a worm-wheel in this way can be practically eliminated. The total distance through which the hob is moved is from one to two times the circular pitch. The movement of the hob along its axis can be accomplished automatically by suitable apparatus properly timed and operating in connection with the driving mechanism of the gear and hob. Although it takes slightly longer to hob wheels by this method, the increased accuracy of the work more than pays for the additional time which is necessary for the operation. This method of gear hobbing is used by the Boston Gear Works where a smooth worm-wheel is required.

Wollaston, Mass. GEORGE L. COLBURN

TURNING TAPERS ON A BORING MILL

In turning tapers on a boring mill with the housings set back, the determination of the proper angle at which the head should be set depends largely upon the judgment of the operator. It is a well-known fact that in operating a machine of this type with the cutting tool behind the center, the elements of the tapered surface are slightly curved instead of being straight lines, as they would be if a true conical surface were produced. This curvature is very slight, however, and does not cause trouble in turning such work as bells, bellhoppers, etc.

The accompanying illustration shows a method of determining the exact angle at which the head should be set for turning tapered work. First, draw a circle of any size to represent the table of the boring mill. Second, draw a line through the center of this circle to represent the center line of the machine. Third, draw a straight line parallel with the center line and at a distance from it which represents the distance that the housings have been set back, to some convenient scale. This line is called "the line of the tool" with the housings set back to the position indicated. Fourth, with the center of the table as a center, draw a circle which represents the



Method of determining Angle of Boring Mill Head for turning Tapers

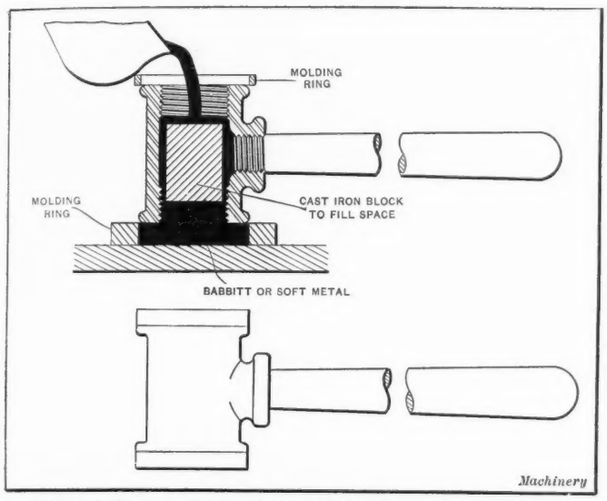
large end of the finished tapered work to scale. Fifth, with the center of the table as a center, draw a circle which represents the small end of the finished tapered work to scale. Sixth, draw the line *AC* parallel to the center line of the boring mill. This line is called "the line of the large diameter." Seventh, draw the line *BD* parallel with *AC* and at a distance from it which represents the height of the finished tapered work to scale. This line is called "the line of small diameter." Eighth, drop two perpendiculars from the line of the tool at the points where this line intersects the two circles which represent the large and small diameters of the work. It will be evident that the space enclosed between these two lines and the lines *AC* and *BD* forms a parallelogram. Ninth, lay a protractor on the diagonal *XY* and measure the angle which this line makes with the line *BD;* this is the angle at which the head must be set to produce the required angle on the tapered work with the housings set back the distance shown in the illustration.

Youngstown, Ohio. S. P. ROBINS

[In the October, 1911, issue of MACHINERY, the curve formed in turning tapers with the housings set back was discussed, and it was pointed out that this curve is a hyperbola. —EDITOR.]

SOFT-FACED MACHINE SHOP HAMMER

For fitting mandrels, and in any other work requiring heavy driving where work must not be marred or scratched, a simple and effective all-metal hammer may be inexpensively and quickly made of a standard T-pipe fitting as shown in the accompanying illustration. The dimensions, of course, will vary according to the work for which the hammer is intended. To make a hammer of this kind, turn a smooth handle of mild steel, thread one end with a pipe die, and assemble as shown in the illustration. Then, with a suitable mold to shape the faces, pour the tee full of lead or babbitt metal. To fill the inner space, any kind of scrap metal may be used inside of the pipe fitting. After the metal has cooled, and if the mold has left the faces rough, unscrew the handle, turn the soft faces smooth in a lathe, replace the handle, and you have a



All-metal Hammer, for use in the Machine Shop where Work must not be marred

hammer that is as serviceable as anything you could want.

As soon as the faces are worn, it is a simple matter to repair them by throwing the whole hammer into the melting pot, melting out the soft metal, and remolding the hammer according to the preceding instructions.

Brooklyn, N. Y. W. F. SCHAPHORST

JIG FOR DRILLING AUTOMOBILE SPRING SHACKLE LINKS

Automobile spring shackle links are generally made from low carbon steel and are sometimes very hard, due to being improperly annealed after having been removed from the forging die. It will be obvious that such hard pieces of work would be very difficult to drill. The accompanying illustration shows a fixture which has been successfully used in drilling these automobile spring shackle links. It is of the box type and consists of a body, cover, end and two V-blocks. One of these V-blocks is fixed and the other adjustable for slight variations in the length of the work. The permanent V-block forms one end of the fixture while the adjustable V-block is held in position by a spring which brings it into contact with the end of the work. The cover of the fixture is hinged to the body and provided with a wing nut lock. A set-screw is carried in the center of the cover and tightened on the work to assist the V-blocks in holding it in position. The holes are drilled through the ordinary form of hardened bushings, and the same fixture can be used for reaming the holes by providing suitable bushings for this purpose. Where it is desired, however, the reaming operation may be done on the bench by hand.

St. Louis, Mo. C. T. SCHAEFER

WHERE IS THE FALLACY?

Replying to your question "Where is the Fallacy?" on page 50 of the September number of MACHINERY, I beg to submit the following explanation:

To repeat the last three lines of the "proof":

$$(a-c)^2=(b-c)^2$$
$$a-c=b-c$$
$$a=b$$

The first equation is correct but the second one is not. After extracting a square root from the first equation the correct result should read:

$$\pm(a-c)=\pm(b-c)$$

thus giving us four possible combinations, namely:

$$a-c=b-c \quad (1)$$
$$a-c=c-b \quad (2)$$
$$c-a=b-c \quad (3)$$
$$c-a=c-b \quad (4)$$

Results (1) and (4) are absurd, but (2) and (3) are correct, each reducing to $a+b=2c$, or just what we started with.

The "proof," as stated in MACHINERY, will remain a proof as long as one forgets that extracting a square root always gives two answers, a positive and a negative.

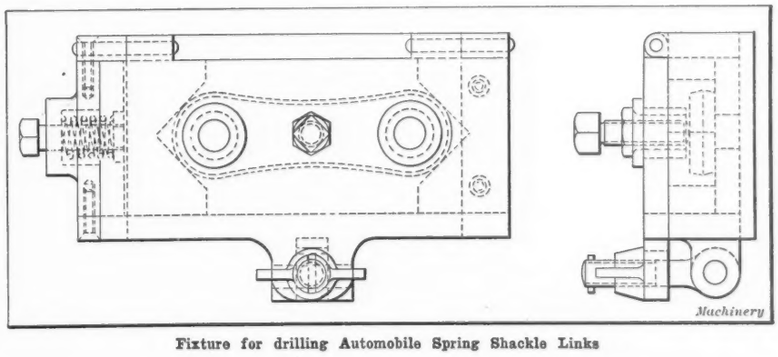
Flint, Mich. M. TERRY

[Correct solutions of this problem were also obtained from G. Brunn, Wilkinsburg, Pa.; T. G. Carlbom, Meadville, Pa.; Asher Golden, New York City; Walter Gribben, Brooklyn, N. Y.; Miss Bernice Haynes, Oxford, Ohio; R. A. Jewett, Rochester, N. Y.; S. G. Koon, Boston, Mass.; Arthur C. Maxfield, Providence, R. I.; E. F. McCaleb, Erie, Pa.; Bernard W. Noel, St. Louis, Mo.; Elof Nordstrom, Hartford, Conn.; R. J. Quinlan, Peterboro, Ontario, Canada; Percival K. Reed, Philadelphia, Pa.; W. A. Rose, Bridgeport, Conn.; J. R. Sheldon, New Haven, Conn.—EDITOR.]

TWO SHOP FORMULAS

The writer was interested in several shop formulas which were presented by Mr. Jos. H. Cheetham in the June issue of MACHINERY. The following gives formulas for two solutions which have been found particularly useful for stripping brass or copper plate from iron or steel articles and for removing rust or scale from various classes of work. The stripping solution is compounded as follows: Dissolve ½ pound of cyanide of potassium and ¼ ounce of cream of tartar in 1 gallon of water. The pieces to be stripped are immersed in the solution and allowed to remain until the plating has been removed. The solution will not injure the work in any way and will leave it nearly as bright as it was before being plated.

The solution for removing rust or scale from iron or steel pieces consists of acetic acid. The work is immersed and allowed to remain until the necessary result has been obtained.



Fixture for drilling Automobile Spring Shackle Links

Winsted, Conn. CHARLES W. RICHARDS

* * *

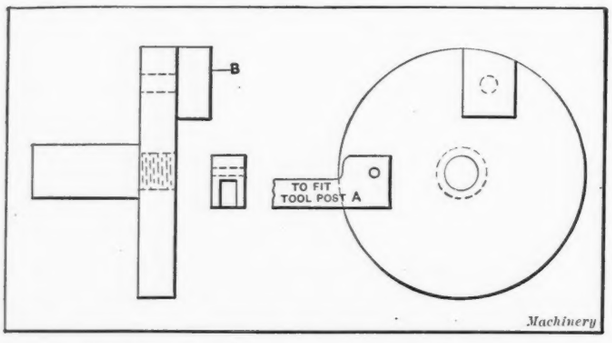
It is difficult to keep a machine from rusting and depreciating in value when it stands idle for a long time. The same is true of men.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

CUTTING OFF PINS ON A BENCH LATHE

A convenient bench lathe attachment for cutting off blanks for pins or rivets is shown in the accompanying illustration. The operation of this device will be readily understood by any mechanic after referring to the illustration. The block *A* is carried by the toolpost of the lathe and has a hole drilled in it of the same diameter as the wire from which the blanks are to be cut. The wire is carried on a reel mounted in some convenient position at the end of the lathe. The block *B* shears the wire off when it comes into contact with block *A*. Block *B* is made of the same width as the length of the blanks which are required. The operator keeps the wire pushed against the faceplate and a blank is sheared off for each revolution of the lathe. The writer operated a machine at 900 revolutions per minute and was able to cut off a blank at each revolution, which gave a productive capacity of 900 blanks per minute.



GEORGE R. HAUB

Bridgeport, Conn.

ERASING INK FROM DRAWINGS

In the April issue of MACHINERY I noticed two methods described for erasing ink marks on tracings. E. C. McMeans tells of using a blotter to blot out the ink before it gets dry. This I have found by experience to work very well, but, supposing a man cannot find his blotter in time, what then? My experience has been that to wipe the ink off with your fingers before it gets dry is the best method in preserving the gloss on tracing cloth.

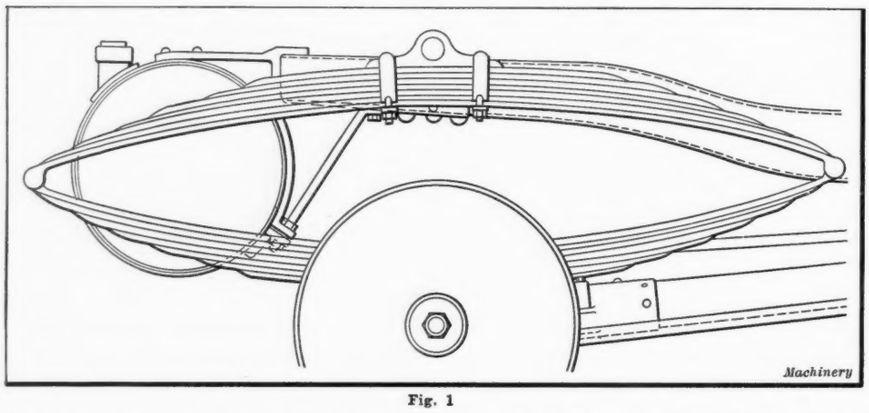


Fig. 1

As to the method of using water before erasing, I would suggest the use of apple juice or vinegar; this will remove all ink without erasing and the effect on tracing cloth is about the same as that of water. If a number of changes have to be made it is time well spent to make an entirely new tracing, thus avoiding confusion and the consequent possibility of making errors.

P. P.

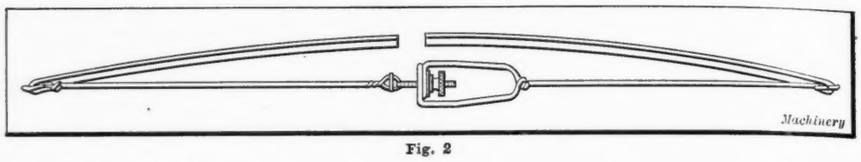


Fig. 2

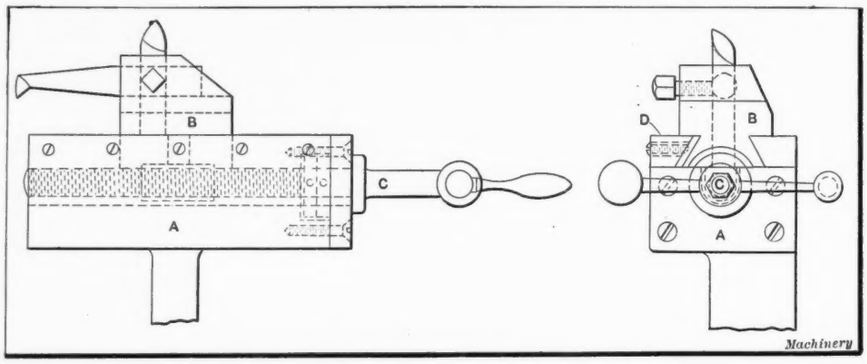
CURVE FOR DRAWING AUTOMOBILE SPRINGS

The writer recently had occasion to draw a number of automobile springs of the form shown in Fig. 1, and as an ordinary irregular curve was not suitable for this purpose, he designed the special curve shown in Fig. 2. This curve is made from a 12-inch hacksaw blade, the ends of which are connected by fine wires and a turnbuckle as shown in the illustration. The screw of this turnbuckle was made from the familiar form of screw used in dry batteries, and by regulating the turnbuckle, the curve could be adjusted to the shape of the various leaves of the springs. In this way it became a very easy matter to make the necessary drawings, as the lines could be swept out at one stroke of the ruling pen.

Jackson, Mich. ALEX. MONCRIEFF

AN AUXILIARY COMPOUND REST

On some of the old types of lathes, it is found very awkward when a job comes along that requires a short taper hole to be bored or an angle turned when the machine is not equipped with a compound rest. In order to overcome this difficulty, the rest was designed that is shown in the accompanying illustration. *A* is a forged block with a shank to fit the toolpost of the lathe. The block *B* slides in *A* and is operated by the screw *C*. There are two holes in *B;* the one parallel to the slide is for a boring tool and the one perpendicular to the slide is for the turning tool; one set-screw locks either tool. To set the rest at the required angle, it is necessary to have a bevel protractor of some sort, the setting being done from the faceplate of the machine, or from an arbor which is between centers and the face *D* of the block *A*. This auxiliary rest will be found handy where there is no lathe available with a compound rest.



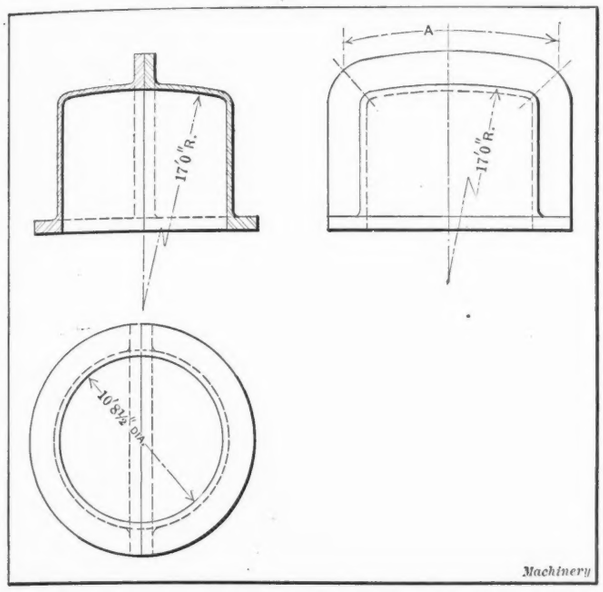
New Britain, Conn. W. C. BETZ

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

BOLTS REQUIRED TO JOIN RECEIVER PARTS

W. N.—What is the proper way to figure the number and size of bolts required to unite the flanged halves of a receiver over the spherical part marked *A* in the accompanying illustration? The receiver is of cast steel and carries an internal



pressure of 125 pounds per square inch. In making calculations, allow 12,000 pounds per square inch fiber stress in the cast-steel bosses and 15,000 pounds per square inch fiber stress in the bolts. I would like to see a discussion of this problem by MACHINERY's readers.

A PROBLEM IN "HEXING"

H. L. B.—We have received an order for 10,000 machine steel plugs like that shown in Fig. 2, which is shown in actual size. We wish to tool-up for this job as there is a likelihood

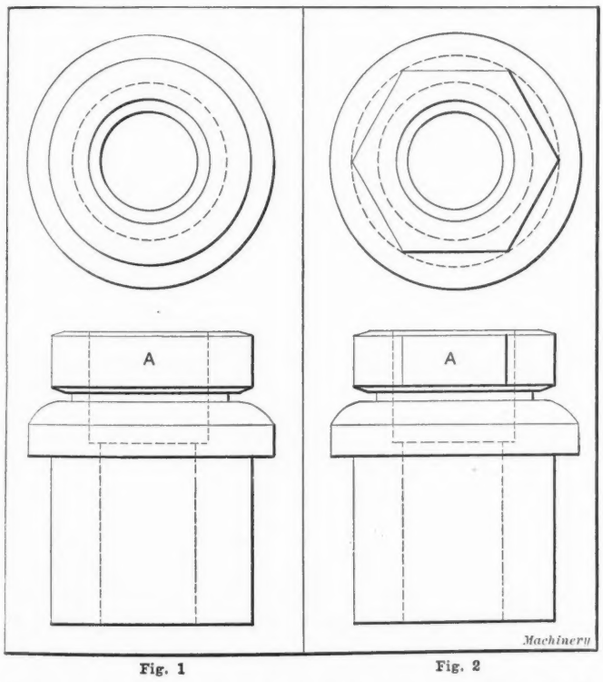


Fig. 1 Fig. 2

that we will receive similar orders of 10,000 lots from time to time. At the same time we cannot go to the expense of making a single-purpose machine unless very simple. We have already the average machine shop equipment, screw machines, power and hand millers, etc. Of course, we know that the job is a plain screw machine proposition as far as shown in Fig. 1, but the phase of the matter which is troubling us is milling the hexagon of the part *A*. We want to do this economically and accurately, although the presence of tool marks on the finished work will not be objectionable. The main thing is to get the pieces out quickly and without a great expense for special fixtures, as competition is very keen on this particular product.

DOUBLE-PLY BELT DRIVE

J. W. W.—I have the care of a belt drive 42 feet from center to center of shafts, the driver being an 18-inch diameter, 24-inch face paper pulley and the driven member a 48-inch cast-iron pulley. A double belt 24 inches wide and ½ inch thick connects the pulleys, and runs at a speed of 3390 feet per minute, the smaller pulley running at 720 R.P.M. I have been unable to keep the belt glued together in the center and will appreciate an expression regarding the cause of the difficulty.

A.—The quality of belt glue and workmanship is of first importance in joining heavy double-ply belts. These must be of the best, but even if they are, the opinion of power transmission experts is that a 24-inch pulley is too small for a half-inch, double-ply belt to run successfully without riveting in the center.

* * *

BROACHING AT THE BOSTON AUTO SHOW

The commercial development of the broaching machine has been coincident with the development of the automobile. The broaching machine is applied to the cutting of square holes in

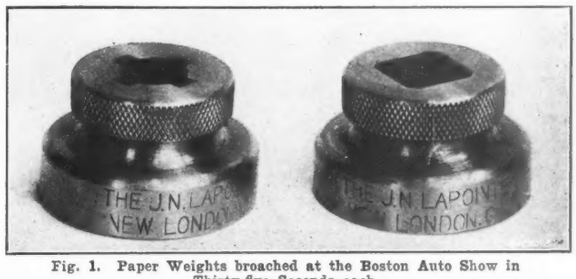


Fig. 1. Paper Weights broached at the Boston Auto Show in Thirty-five Seconds each

gears and multiple keyways for splined shafts characteristic of the design of gear boxes, etc. The J. N. Lapointe Co., New London, Conn., exhibited one of its broaching machines at the Boston Auto Show, in operation, broaching samples similar to those shown in Fig. 1, which were given away to

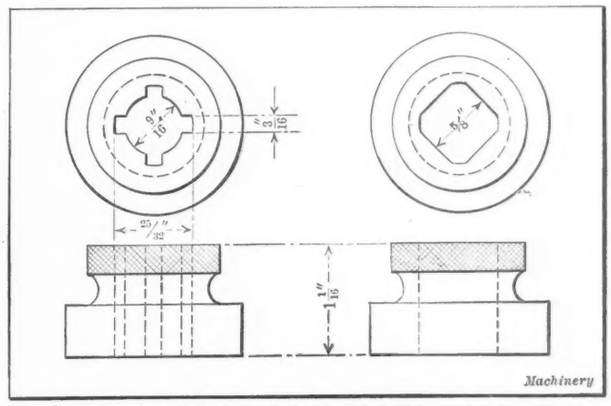


Fig. 2. Showing Dimensions of the Broached Holes and Spline Ways

be used as desk weights. Fig. 2 gives the dimensions of the broached holes and spline ways. The samples shown in Fig. 1 were broached in the remarkable time of thirty-five seconds each, including putting on the broach and removing from the machine.

* * *

Some great and revolutionary improvements in machinery or methods are so simple that when demonstrated we wonder why they were not thought of before. The greatest improvements are often of the simplest character.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

PRATT & WHITNEY HORIZONTAL SURFACE GRINDER

For a number of years the Pratt & Whitney Co., Hartford, Conn., has been manufacturing surface grinders equipped with cup wheels which are well adapted for work on simple, plane surfaces. This machine was not, however, adapted for grinding work having surfaces lying at different heights or angles, and work of this character was slow and expensive to handle. Either the planer type or tool-room type of surface grinder has been used for such work. The wheels of both types of machine are mounted on slides which provide either vertical or horizontal adjustment, or both. The design is usually such that the wheel has an unsupported overhang, and in order to get accurate work, the adjustment of the slides must be maintained very closely. Trouble has also been experienced from wear in the slides resulting from emery dust or water getting into them.

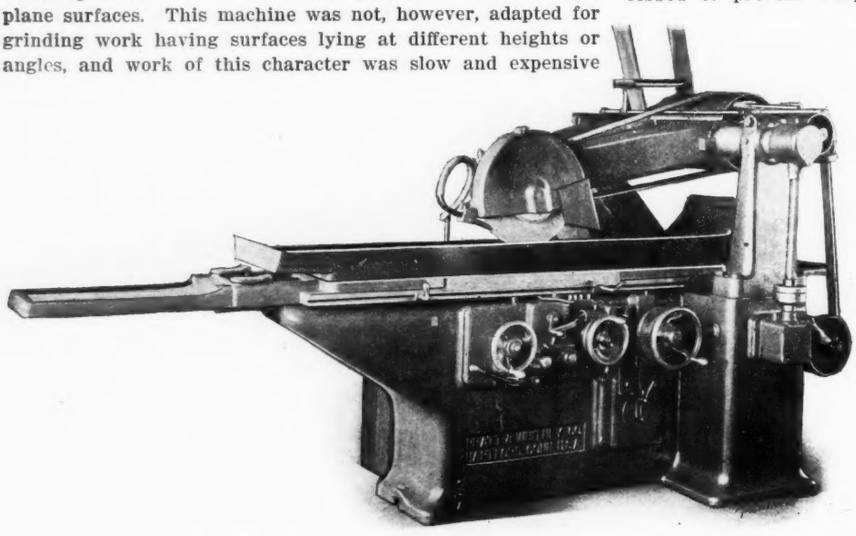


Fig. 1. Front View of Pratt & Whitney Horizontal Surface Grinder

With the view of eliminating these troubles the Pratt & Whitney Co. has developed the horizontal surface grinder shown in the accompanying illustrations. This machine is adapted for general classes of surface grinding, although it has been designed particularly for grinding work with surfaces lying at different heights or angles. This machine is equipped with large wheels which are powerfully driven and the design has been worked out to provide the maximum rigidity and also to enable a liberal supply of water to be utilized during the grinding operation. During recent tests to which machines of this type have been subjected in the factory of the Pratt & Whitney Co., it has been fully demonstrated that they are capable of handling grinding operations on surfaces lying in different planes, with great efficiency.

The bed is very massively proportioned and internally braced in a manner that insures ample rigidity and permanent accuracy. It is very compact in design, the various units being located so as to be conveniently accessible. Wide bearing surfaces of the vee and flat types are provided. Oil reservoirs are located in the bed to provide for automatically oiling the ways by means of rolls. The pan which surrounds the rear of the bed for collecting the water and receiving the chips is of liberal proportions and is easily accessible for cleaning. The table is of heavy construction and powerfully ribbed to prevent warping and to resist torsional strains. Both the bed and the table are scraped perfectly true by means of masters, the table being slightly longer than the bed; and the traveling action tends to keep these members perfectly true. The table is provided with guards at each end, which, at all times, cover and protect the bearing surfaces from injury. A spacious water pan is cast integral with the table.

The table is provided with automatic reciprocating motion, any length of stroke up to four feet being readily obtainable by means of adjustable table dogs. The table feed mechanism is of a most efficient and substantial design. It is made in a simple, compact unit which is very easily accessible. Two table feeds are provided, both of which are instantly controlled by means of a lever conveniently located at the front of the machine. This lever when adjusted to the central station also serves as a means for stopping the table; when adjusted to the upper station the slow feed is engaged, and the lower station engages the fast feed in a similar manner. The table is driven through a rack and pinion vertically located, which eliminates vibration and prevents "tooth-marks" showing in the work.

The machine is provided with both hand and automatic horizontal feed. While the power feeds for both the table and horizontal wheel movement are engaged through the same trip, the feed units are entirely independent of each other. This is very important, as by having a separate mechanism for each feed there is no extra load thrown upon the table feed mechanism when the wheel feed is engaged, and it is a well-known fact that when intermittent loads are thrown upon the grinding table it will invariably show in the work.

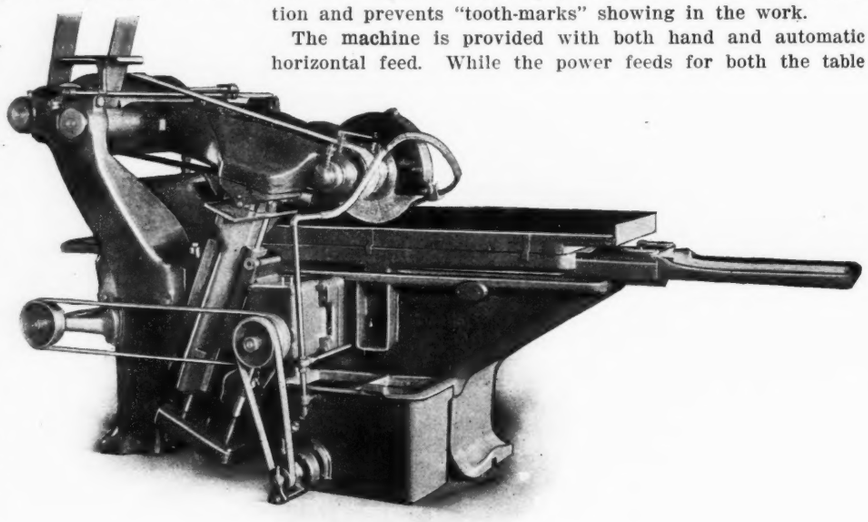


Fig. 2. Rear View of Horizontal Surface Grinder

The feed mechanism operates a screw mounted inside the hollow arbor upon which the arm is mounted. This screw engages a nut clamped to the arm, both the screw and nut being of liberal proportions and easily accessible. It will be observed that the feed mechanism is entirely enclosed so that it is impossible for emery or dirt to injure it in any way. Any variation of feed is readily obtainable by means of a ratchet wheel and pawl. The feed is operative in either direction and is governed by the direction in which the pawl is engaged. A safety device is also provided, which prevents injury to the feed mechanism in case the arm should come into contact with the uprights, due to neglecting to disengage the feed mechanism. The feed, however, may be very accurately governed by means of a handwheel, the periphery of which is graduated in thousandths; and the diameter of this wheel is so large that these graduations may very readily be observed. The feed operates at the end of each stroke when the wheel is entirely clear of the work.

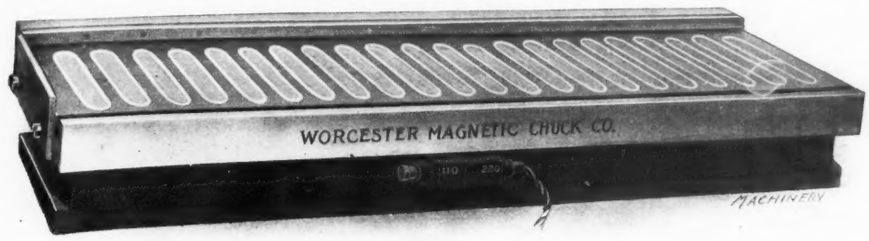


Fig. 1. Worcester Magnetic Chuck for use on either 110 or 220 Volt Circuits

The vertical wheel feed is through hand only, a graduated handwheel being conveniently located on the front of the machine for this purpose. The inclined ram, by means of which the wheel is raised or lowered, is rigidly supported in long bearings. The construction is such that this ram is raised or lowered by means of a heavy screw and nut, the screw being driven through a worm and worm-wheel, actuated by the handwheel referred to. A hardened and ground plate is mounted on top of the ram, which engages a similarly treated block on the under side of the arm. The construction is such that the block always has a full bearing on the plate, irrespective of the height or horizontal position of the wheel. The ram and block take the full weight of the arm, which entirely eliminates backlash in the mechanism. This is a most important feature and one directly conducive to accurate work.

A most important and original feature is the method of mounting the wheel in an arm, which entirely eliminates the use of a slide construction. The arm has a perfect fit on an arbor, which is substantially supported upon two uprights, both the arm and the arbor being proportioned to insure absolute strength and rigidity. With this construction, the wheel is adequately supported without overhang. Furthermore, it simplifies the control of both the vertical and horizontal feeds. It will be noted that the arm has a liberal bearing on the arbor, the bearing surfaces being absolutely protected by means of wipers.

The spindle is of tool steel, hardened, ground and lapped, special treatment and care being exercised to insure the highest possible efficiency of this important member. The boxes are made of bronze and mounted in conical seats. They are made and located so as to be easily accessible for adjustment, and are absolutely dust- and water-proof. Extra precautions have been taken to insure proper lubrication, large self-feeding oilers being provided. The wheel-mount is self-contained and constructed so as to hold the wheel firmly and perfectly true. The spindle end is made conical and provided with a key for the accommodation and positive driving of the wheel-mount. The machine is designed with a view of using wheels up to 18 inches diameter by 2-inch face. Suitable packing rings, however, are provided which permit the use of wheels as thin as 1-inch face.

The wheel spindle drive is of liberal proportions throughout, so that there is no question as to whether the wheel will have sufficient power for any requirement. Two speeds are provided by means of a two-step cone, so that when the wheel is reduced by wear, its speed may be increased. The mechanism for shifting the belt to obtain the increased speed of wheel is so designed that it also becomes necessary to proportionately decrease the table feed. The wheel is driven from a drum, which is finished perfectly true, so that there is no vibration.

A most important feature in these machines is the liberal and perfectly controlled water supply. It is well known that in order to keep the wheel free and prevent clogging, as well as to prevent heating of the work, a liberal supply of water is absolutely necessary. The type of pump used is made and located so as to entirely dispense with the usual idler pulleys. It is capable of supplying an abundance of water for any condition under which the grinder may be operated. An exceptionally large water tank is located on the back of the machine, where it is in an accessible position so that it may be readily cleaned. This arrangement also permits the return of the water without requiring it be carried through pipes; in fact, the design is of such a nature throughout as to make the collection of dirt or grit in inaccessible places impossible. The pipe through which the water is conveyed to the wheel is attached to the guard and may be easily adjusted or instantly removed as desired. Both the table and wheel are provided with guards to prevent the escape of the water.

WORCESTER MAGNETIC CHUCKS

Two forms of electro-magnetic chucks which are now being manufactured by the Worcester Magnetic Chuck Co., 47 Hermon St., Worcester, Mass., are illustrated in Figs. 1 and 2. Referring to these illustrations, it will be seen that the faces of the chucks are designed with "holding spots" which are made of steel. These holding spots are at the ends of the pole-pieces about which the electro-magnetic fields are wound. The use of steel for this purpose has two advantages; it adds

Fig. 2. Worcester Round Magnetic Chuck

to the wearing capacity of the chuck and also affords a stronger magnetic action. As each pole constitutes an independent unit, any accident which may put one pole out of commission does not affect the efficiency of the other poles. The chuck is both heat- and water-proof and does not require ventilation.

Fig. 2 shows a round chuck which is capable of holding work as small as rings of 1¼ inch diameter. Each of the electro-magnetic coils in these chucks is enclosed in a fiber case which makes it impossible to ground the chuck. The rectangular chuck (Fig. 1) is designed to hold pieces from ½ inch in diameter up to the full size of the chuck. This chuck is wound for connection to either 220 or 110 volt circuits. In order to change from one voltage to the other, it is only necessary to take off the "volt box" on the side of the chuck and change the wires. No resistance is required with these chucks.

"NATIONAL" HEAVY-PATTERN FORGING MACHINE

On account of the general adoption of high-carbon and alloy steel in engine and machine construction, a gradual development has taken place in the design of machine tools to increase their power and capacity. In the railroad, automobile and industrial shops, for instance, there is a general tendency to use forged parts made from wrought iron, soft steel, high-carbon and alloy steel, to replace castings of iron, steel and malleable iron, due to the greater strength possessed by forged parts, and also to the fact that forgings last longer and are much cheaper when produced under proper conditions. The automobile industry particularly has made a great advance in the adoption of forged parts made from alloy steels, and heretofore forging machine equipment has not had the capacity or strength for making these parts economically.

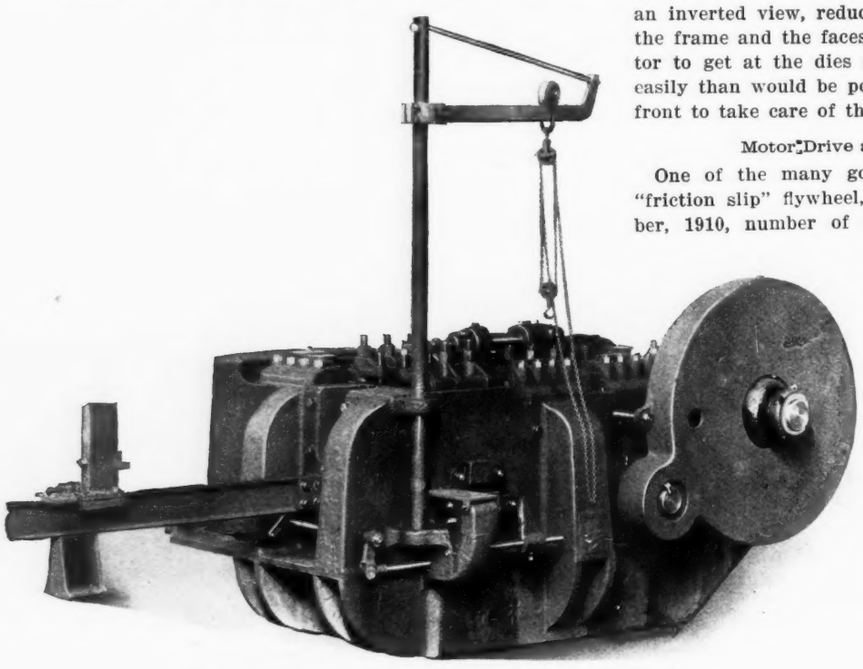


Fig. 1. "National" Four-inch Heavy-pattern Forging Machine

The National Machinery Co., Tiffin, Ohio, manufacturer of bolt, nut and forging machinery, has recently brought out a new design of forging machine which embodies some radical departures in its construction. It has been designed not only for handling forgings much more economically than machines formerly built, but will operate on high-carbon and alloy steels with the same facility as on wrought iron or mild steel. It is designed along lines that give it a higher factor of safety than is customary in forging machines, and it is provided with reliefs on the gripping and heading slides.

Bed-frame Construction

Figs. 1 and 4 show the bed frame construction which extends considerably below the floor line, is heavily ribbed and is of trussed frame section. This bed frame is one massive steel casting of heavy pattern type designed to secure a high degree of stiffness, as well as great strength. The aim in designing this frame has been to distribute the metal in the paths of the stresses so as to overcome the objectionable spring prevalent in forging machines made from steel beds of lighter design. It also eliminates the use of tie rods and similar stiffening members, making the machine much more accessible. By carrying the frame below the floor line, and providing the ribbing illustrated clearly in Fig. 4, springing at the gap of the bed is eliminated. This is a very important feature in a forging machine, because if the bed frame is not rigidly constructed near the gap, it weakens the gripping power of the machine, allowing the work to slip and produce excessive fins and flashes on the work. Making the bed frame like the construction illustrated in Fig. 4, which is an inverted view, reduces the distance between the front of the frame and the faces of the dies, thus enabling the operator to get at the dies and operate the machine much more easily than would be possible if the frame were built out in front to take care of the stresses mentioned.

Motor-Drive and "Friction Slip" Flywheel

One of the many good features of this machine is the "friction slip" flywheel, which was described in the November, 1910, number of MACHINERY. While this flywheel is intended primarily to furnish a means for safety or relief on the heading movement, it also provides an element of elasticity which is highly essential between the motor and a machine of this type. This is due to the varying strains thrust upon the motor by the gripping and heading movements, and especially when the machine is accidentally "stalled" by cold stock or excessive metal. The motor carries a rawhide pinion that meshes directly with a gear bolted to the flywheel. This forms a compact and simple design, insures quiet operation and eliminates the excessive upkeep incident to the chain or flexible joint drive.

Automatic Grip Relief

The top view of the machine, Fig. 3, shows the gripping dies in their closed position and the heading tool or plunger just as it starts gathering the stock on the upsetting stroke. The heading slide is actuated by a crank, while the gripping slide is controlled by two cams, one effecting the closing of the dies and the other serving to open the dies. By employing two cams for the operation of the gripping dies, the opening and closing movements are so timed as to secure practically the entire stroke of the heading tool for useful operation. This gives the machine an unusually large gathering capacity, that is, the ability to upset a large amount of stock at one stroke of the heading plunger. The double cam mechanism also enables the dies to be opened wide, and this, with the large gathering capacity, makes this machine capable of handling large and difficult shaped forgings.

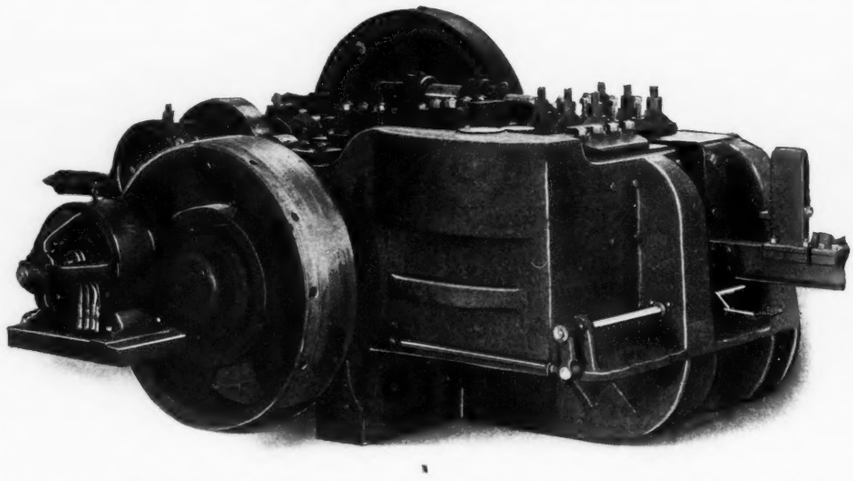


Fig. 2. "National" Four-inch Heavy-pattern Forging Machine with Direct Motor Drive, the Motor being geared directly to the Friction Slip Flywheel

The safety relief for the gripping slides as shown in Fig. 3 consists of a by-pass toggle, the action of which is illustrated in the diagrams Figs. 5 and 6. This relief is so designed that but a small part of the gripping pressure or power is dependent upon the toggle and spring which holds the toggle

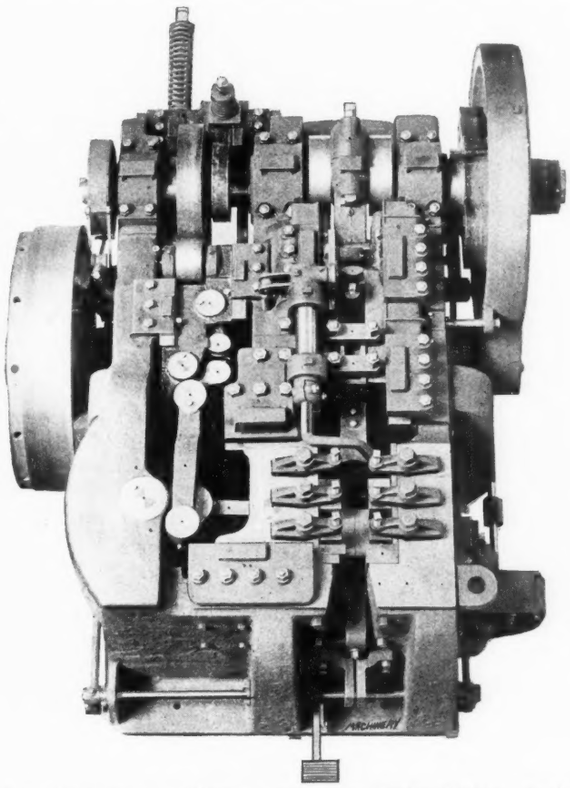


Fig. 3. Top View of "National" Heavy-pattern Forging Machine, showing Method of operating the Gripping Mechanism and Heading Slide

in the normal position, and does not relieve the machine until the same strains are secured in the dies, which in ordinary relief designs would shear the breaker bolt or pin. This design provides for a powerful gripping action in the dies and also enables squeezing or swaging operations to be performed

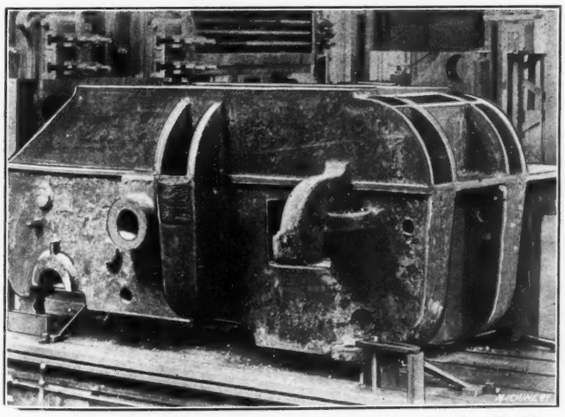


Fig. 4. Steel Bed Casting of National Heavy-pattern Forging Machine, showing the Heavy Under-ribbing that extends below the Floor Line

between the opposing faces of the gripping dies, as is illustrated by the examples shown in Fig. 7. These bars range from 2 to 3½ inches in diameter and were flattened or squeezed in a heated state between the surfaces of the dies in one operation. The ability to handle such squeezing or swaging operations enables a wider range of work to be accomplished, and this feature has met with much favor by forge-shop superintendents.

Briefly stated, the automatic grip relief operates in the following manner: When a piece of stock or other object becomes caught between the gripping dies, or in shop vernacular, the operator gets a "sticker" in the dies, the gripping action continues until the strain incurred in the dies exceeds the combined gripping power derived from the main or fixed toggle and the by-pass toggle, causing the by-pass toggle to open and compress the relief spring, thus stopping the movement of the gripping slide. The heading tool or plunger, however, completes its full stroke, and upon the return stroke of the machine the by-pass toggle resets automatically, without any attention on the part of the operator. This, of course, eliminates all shutdown, which is necessary with the ordinary safety devices, such as the breaker bolt, etc., sometimes provided.

Suspended Gripping and Heading Slides

Another valuable feature that has been incorporated in this design of forging machine is the suspended type of head-

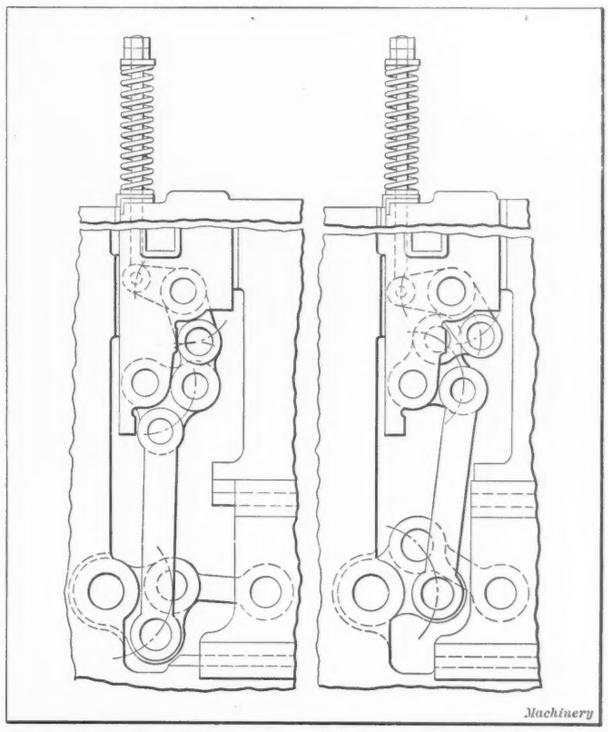


Fig. 5. Automatic Relief for Gripping Slide in its Normal Position

Fig. 6. Automatic Relief in its Tripped Position

ing and gripping slides as shown in the sectional views Figs. 8 and 9. In this type of slide it can be seen that the supporting bearings are at the top instead of at the bottom. This feature removes the bearings from the line of water and scale, increases perfect lubrication and eliminates the causes of "cutting out," as it prevents the water and scale from getting in between the working surfaces. With the ordinary

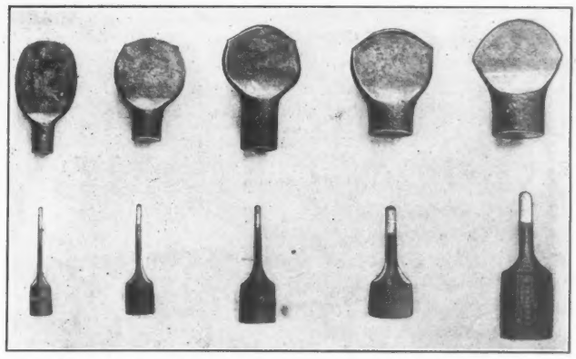


Fig. 7. Squeeze Jobs or Swaging Operations accomplished between Gripping Dies of National Heavy-pattern Four-inch Forging Machine

type of slide where the bearings are at the bottom, water and scale drop down upon the ways and are picked up by the reciprocating movement of the slides, thus causing friction or abrasion with attendant wear. This makes it difficult to maintain alignment. Figs. 7 and 8 also show the wedge

construction back of the side liners on the heading and gripping slides. With this construction shimming can be added when needed without removing the slides or liners, thus providing an easy means of maintaining a snug contact between the slides and liners, and preserving perfect alignment.

Miscellaneous Features

The slide, toggle and shaft bearings are of especially large area and a special effort has been made to minimize the wear

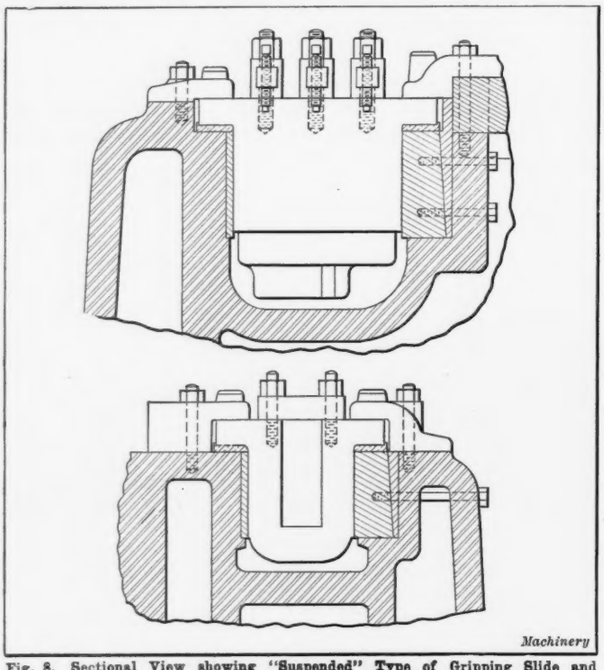


Fig. 8. Sectional View showing "Suspended" Type of Gripping Slide and Method of lining and gibbing

Fig. 9. Sectional View showing "Suspended" Type of Heading Slide and Method of lining and gibbing

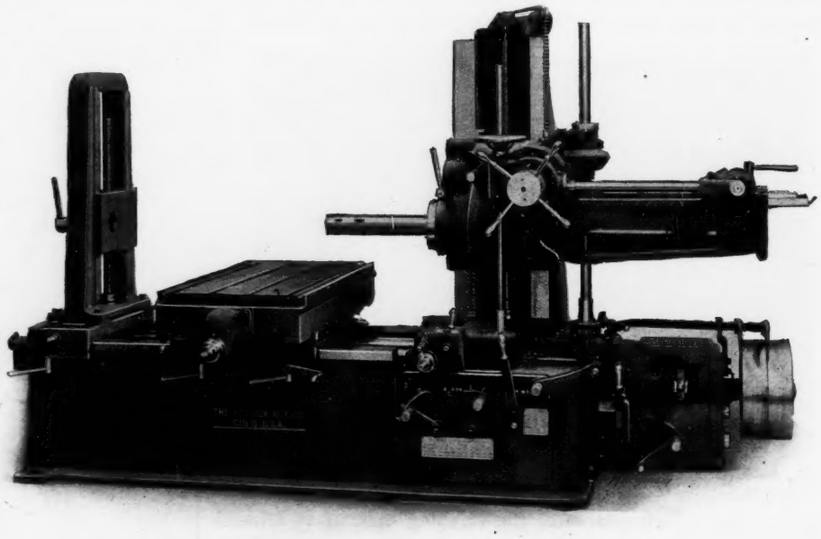
by facilitating lubrication. Large oil boxes provided with covers furnish a means of lubricating the slides and main shaft, and oil cups with connecting ducts take care of the bottom toggle bearings and the suspended slides, thus eliminating the source of the greatest trouble in the lubrication of forging and upsetting machines. This new heavy-pattern forging machine is built in sizes ranging from 2- to 5-inch capacities, but due to the larger movement and greater strength of this design, the range of all sizes is increased so that they will safely handle any forge-shop work that has been taken care of on so-called 6-inch machines, and various smaller sizes. A 5-inch "National" machine will easily handle work that has heretofore been only possible on a regular 6-inch machine. A number of these 4-inch machines have been supplied to the automobile trade for use on high-carbon and alloy steels, and have been viewed with interest by shop managers and superintendents when in operation in the shop of the manufacturers where demonstrations are made at the completion of each machine.

FOSDICK BORING, DRILLING AND MILLING MACHINE

The No. 0 horizontal boring, drilling and milling machine shown in this connection is a product of the Fosdick Machine Tool Co., Cincinnati, Ohio. This company has been manufacturing a machine of this type for several years, but the present design has been improved in many ways. Among these improvements may be mentioned: The control has been centralized to facilitate convenience in operation; all gears are of steel and the bevel gears are planed to a theoretically correct outline; self-oiling bearings are used which are provided with phosphor-bronze bushings; all clutches, gears and other moving parts are thoroughly incased; and precision micrometer dials are provided which can be set back to zero from any position.

The bed is of deep section and well ribbed to provide adequate rigidity without the use of any special foundation. Chip chutes are provided which carry the chips and dirt away to the rear of the machine. The head and outer support are raised and lowered simultaneously by means of a rapid power traverse, by hand or by the feeds, the elevating screw being suspended from a ball bearing at the top in order to avoid buckling. Automatic safety trips are provided at both extremes of the travel. The spindle is driven by two long keys and slides in a sleeve with a phosphor-bronze bearing, which is tapered to provide compensation for wear. The thrust is taken on a ball bearing. The quick advance and return turnstile is placed at the front of the head where it is within easy reach of the operator. The sleeve surrounding the spindle is so designed that the spindle is held in perfect alignment regardless of wear.

The table is of heavy construction and is scraped so that it is absolutely square with the spindle. It is provided with an oil channel running all the way around and has automatic safety trips at either extreme of its movement. The feed mechanism is enclosed, all of the feed gears being of steel. The changes are made by means of two handles at the front without the necessity of stopping the machine. A safety friction device, which is adjustable from the outside, prevents the possibility of damage to the feed mechanism. The rates of feed are given on a metal feed-plate and are the same for the spindle, table and saddle or head, so that the selection of the proper feed is made by means of only one handle. This makes it impossible to get any but the desired movement. The direction of the feed reverses when the spindle is reversed and stops when the spindle is stopped.



Fosdick No. 0 Combination Boring, Drilling and Milling Machine

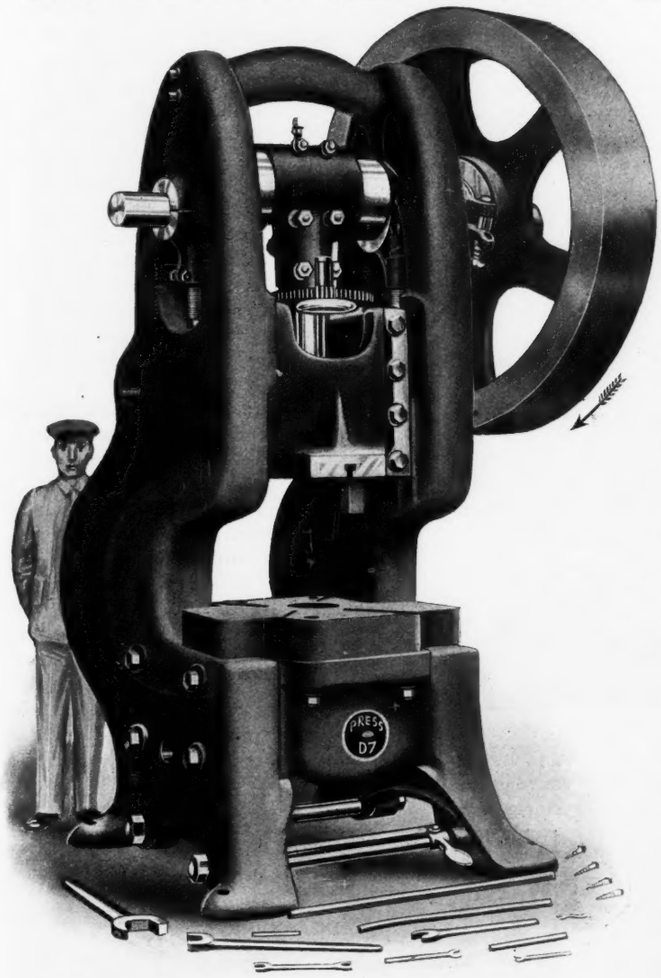
An independent feed reverse lever is provided and power rapid traverse for all members of the machine is always in the opposite direction to the feed.

The drive is direct, so that no countershaft is required, and the machine is equipped with a direct reading index over the speed-changing handle which gives the revolutions per minute of the spindle. An overtake clutch keeps the machine running at a reduced speed while making changes, so that any possible shock is reduced to a minimum. A re-

verse mechanism is embodied in the construction and is operated by a lever located at the front of the machine. All levers are secured by latches. Motor drive may be added to this machine at any time, a five-horsepower constant-speed motor of the required speed being suitable for this purpose. The principal dimensions of the machine are as follows: Traverse of the spindle, 26 inches; vertical adjustment of the head on the column, 25½ inches; maximum distance from the table to the center of the spindle, 26 inches; cross travel of the table, 30 inches; longitudinal travel of the table, 32 inches; number of feeds, 18; range of feeds, 0.004 to 0.396 inch; approximate net weight, 8500 pounds.

FERRACUTE SINGLE-ACTION PRESS

The Ferracute Machine Co., Bridgeton, N. J., has recently brought out a line of throated, single-action power presses which are made in sizes capable of exerting pressures of 100, 150 and 200 tons. These machines are built with either a heavy flywheel or gearing, the flywheel type being shown



Ferracute Single-action Power Press equipped with a Pin Clutch

in the illustration, which shows a machine capable of exerting a pressure of 150 tons.

The shaft of this machine is a high-carbon steel forging which is 6½ inches in diameter at the journals and 7½ inches at the crank. The hole through the bed is oblong in shape, being 20 inches from front to back and 18 inches from right to left. The distance between the columns is 32 inches and the throat—from the center of the ram back to the frame—is 15 inches. The height from the bed to the ram when at the top of its stroke and adjustment is 21 inches; the stroke of the ram is 3 inches and the maximum adjustment of the ram 4 inches. Machines can be built with different lengths of stroke to meet the requirements of individual cases. The flywheel is 55 inches in diameter by 10 inches face width and weighs 2600 pounds. The bolster is 4½ inches thick and measures 28 inches from front to back by 26 inches right to left. The total weight of the press is about 26,200 pounds.

POTTSTOWN AUTOMATIC VALVE MACHINE

The illustration shows a semi-automatic 4-inch valve tapping, reaming and seating machine which has been brought out by the Pottstown Machine Co., Pottstown, Pa. It is intended for finishing semi-steel valve bodies, pieces with flanged or threaded ends, split return bends and similar work which requires two or three operations in one chucking. The machine is of heavy construction, which gives such rigidity that any possibility of the work shifting while the machine is in operation is practically eliminated. Eight spindles are provided, either or all of which can be used according to the work on which the machine is engaged.

The turret is revolved and indexed by means of a pneumatic cylinder. This turret has four sides, each of which is provided with chucks, the work in three of the chucks being operated upon while a piece is being set up in the fourth. The first operation is performed on the work at the left-hand side of the turret, where the three roughing tools enter the valve and remove all scale surfaces. The work is then carried to the second position, where the finishing tool at the rear (which does not show in the illustration) comes into action. Two spindles are provided in this position—one horizontal and one vertical—for finishing either straight through or angle valves. After the work has been carried to the third position, two facing tools come into action which finish the male and female members. The turret then moves to the fourth position where the finished valve is removed and a fresh casting mounted in its place.

On the right-hand side there is an additional wrist plate, cam and lever mechanism. This is the tapping side of the machine. It is possible to throw the automatic reversing mechanism out of commission and make the spindles rotate in one direction only, thus permitting finish-facing tools to be mounted in these spindles for machining flanged work. The machine is shown operating in this manner in the illustration. By disconnecting the wrist plate, placing lead-screws on the spindles and putting the reversing mechanism into commission, the machine is made ready for operations on tapped openings.

The turret is held and indexed by means of a substantial latch bar and is further supported by an automatic locking device which holds it securely to the main frame of the machine. This arrangement insures absolute alignment and accurate work. The turret may be revolved without the tools coming into operation as long as the cam trip is not pressed down. After the work has been placed in the chuck and the turret moved to its first position, the machine passes through the cycle of operations which is necessary to finish the piece. After the tools have been set, there is nothing further to be done except to take out the finished work and replace it by a new blank.

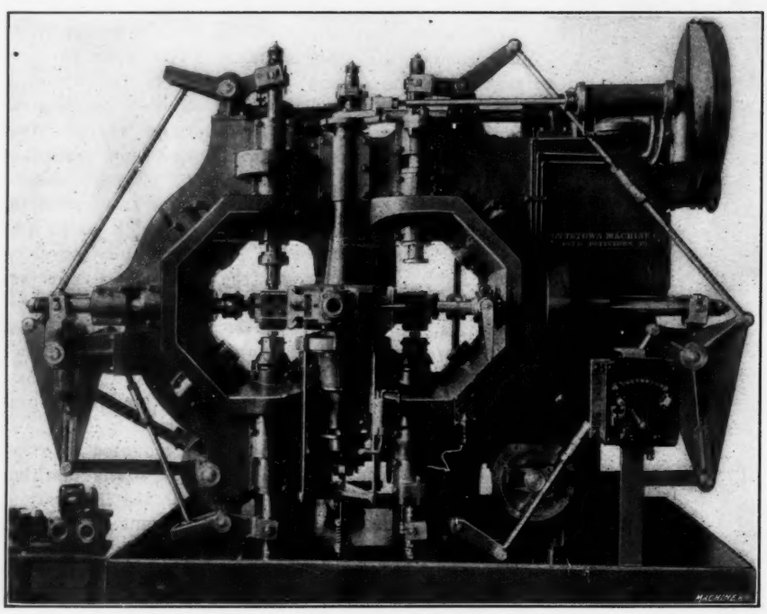
The adjustments are adequate for the range of the machine from the largest to the smallest sizes of work. In order to secure rigidity, the chucks are provided with right- and left-hand screws that are coupled in the center by a sleeve; this sleeve receives the two ends of the screws which are machined to fit it. The action of the wrench on one end of these screws is to tighten the jaws on the work, causing them to separate slightly in the middle and come up solidly at either end of the chuck. No dependence is placed on a bracket or collar to provide the necessary rigidity. Consequently, when the work is fastened in the chuck, it is practically as solid as the turret itself.

Solid taps are used, the taps being fed in by adjustable lead-screws. In order to facilitate gaging, the leader nuts

are castellated and the use of a spring latch enables the nuts to be revolved from one notch to another to regulate the depth of thread. The lead-screws are removable and can be readily changed for different pitches. The taps are started automatically by the cam-shaft, but the reversing is done by a stop carried on the reversing disk. Any depth of thread can be cut by simply adjusting these stops. The variation in the thread is adjusted by the lead-screws as explained.

The four-sided turret used on this machine enables the work to be brought close to the operator, and thus greatly facilitates chucking. The simplicity of the method of setting up the machine for different jobs is also a material advantage. In starting on a piece of work, the turret can be moved back and forth to the different tools so that all testing and gaging may be done on the first piece. The ability of the machine to perform the third operation described in the cycle is also a valuable feature. For machining globe valve bodies, roughing tools may be used to remove the surplus stock and for rough-reaming, while finishing tools are used for accurately finishing all of the openings at a single chucking. When handled in this way, the work will be more accurate and the tools will last longer.

All gears used in this machine are made of either cast or forged steel with cut teeth. All of the clutches are made of



Pottstown Machine for tapping, reaming and seating Valves

hardened tool steel and the spindles are of a special steel which is particularly adapted for this purpose. The spindles are provided with taper bushings for taking up wear. All of the bearings are of ample proportions and provided with oil grooves to facilitate lubrication. The hand levers which govern the various movements of the machine are conveniently placed for the operator. The floor space occupied is

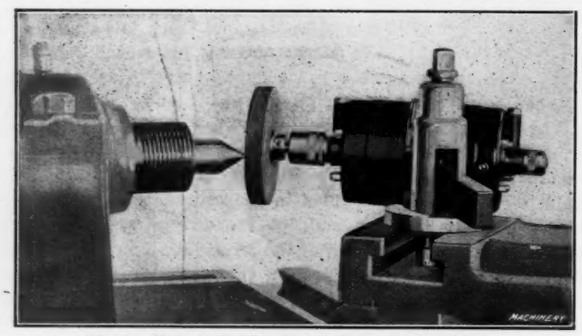


Fig. 1. Method of using Racine Lathe Center Grinder

9 feet 6 inches by 6 feet 1 inch and the weight of the machine is 20,800 pounds. During a recent test, the machine turned out 2-inch semi-steel valve bodies at the rate of twenty per hour.

RACINE PORTABLE ELECTRIC GRINDERS

The Racine Electric Co., Racine, Wis., with sales offices in the Matthews Building, Milwaukee, Wis., is now manufacturing the portable electric grinders shown in Figs. 1 to 4.

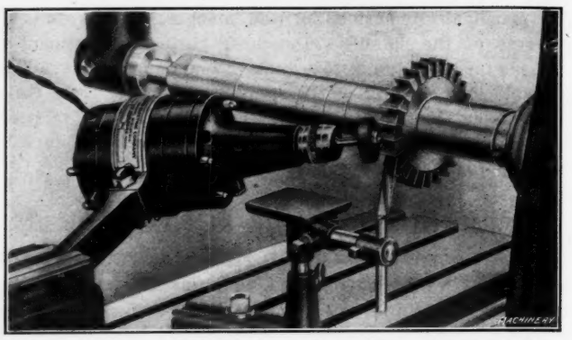


Fig. 2. Grinding a Milling Cutter with the Racine Toolpost Grinder

Referring to these illustrations, it will be seen that one of these tools is intended for grinding lathe centers while in position and that the other is a toolpost grinder. The illustrations show several uses to which this grinder can be put.

Fig. 1 shows the method of using the lathe center grinder, the operation being obvious to any mechanic without requiring a detailed description. It is merely necessary to place the grinder at the proper angle in the toolpost and drive the lathe and grinder in opposite directions. In this way, lathe centers can be ground in far less time than it takes to remove them from the machine, draw the temper and true them in the ordinary manner. The grinder is equipped with a 3½ by ½ inch wheel and the spindle runs in adjustable bearings. The motor develops 1/6 horsepower and drives the wheel at 6000 revolutions per minute. This grinder is adapted for use in any standard sized lathe and can be used for large internal and external work in addition to grinding centers.

Figs. 2 to 4 show another portable electric grinder of this company's manufacture engaged on three typical operations. In Fig. 2, the grinder is shown sharpening a cutter while in place on the milling-machine arbor. Used in this way, the tool is capable of producing very accurate results and saves the time necessary to take the cutter off the machine and set it up on a tool grinder. Fig. 3 shows the grinder engaged upon internal work. For this purpose, wheels

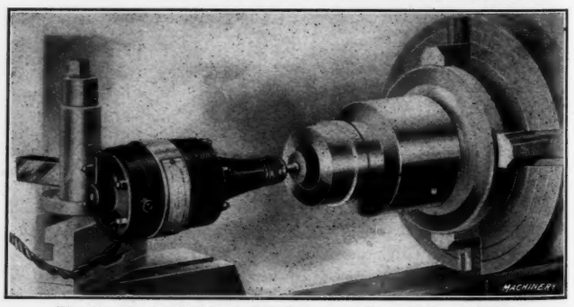


Fig. 3. Racine Toolpost Grinder engaged on Internal Work

ranging from ¼ inch to 2 inches in diameter can be used, and for very small work an extension is furnished. For work on which a very smooth surface is necessary, oil-stone wheels can be used. In Fig. 4 it will be seen that the grinder is mounted in the toolpost of a shaper and is engaged in grinding a plane surface. Many dies and other hardened pieces warp slightly during the heat-treatment, and by using the grinder in this way, a convenient means of eliminating such errors is provided.

The following gives a brief description of the construction of the motors used to drive these tools. The armature is built up of thin laminations of steel and is pressed onto a steel shaft which has been ground to an accurate finish. The windings are of double silk-covered wire and are thoroughly impregnated with insulating varnish. The commutator is built up from twenty-four hard-drawn copper segments separated by mica insulations. The brushes are made

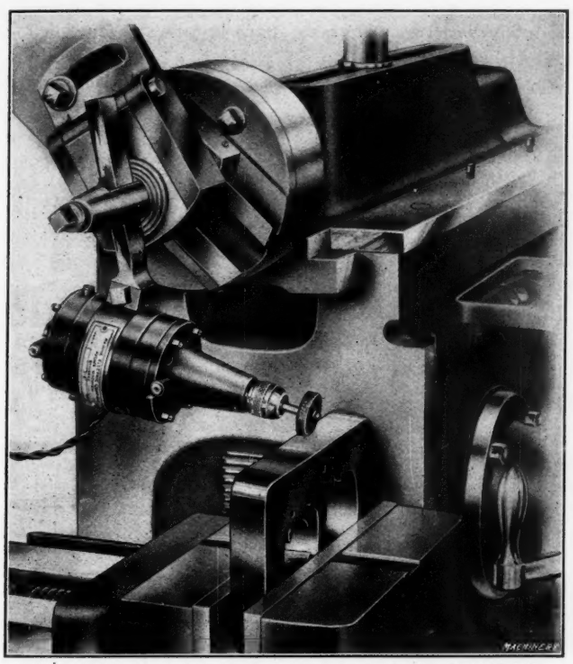


Fig. 4. Grinding a Plane Surface with the Racine Toolpost Grinder

of carbon and provided with means for automatic adjustment. The armature spindle bearings are lined with babbitt of a special mixture adapted for high speed; after the babbitt lining has been put in the bearings, the motor casing is chucked in a screw machine and the bearings are reamed, burnished and faced. By this method perfect alignment of the bearings is insured. The motors are "universal" in that they are capable of operating on either alternating or direct current of 100 to 130 volts.

DRESES SIX-FOOT UNIVERSAL RADIAL DRILL

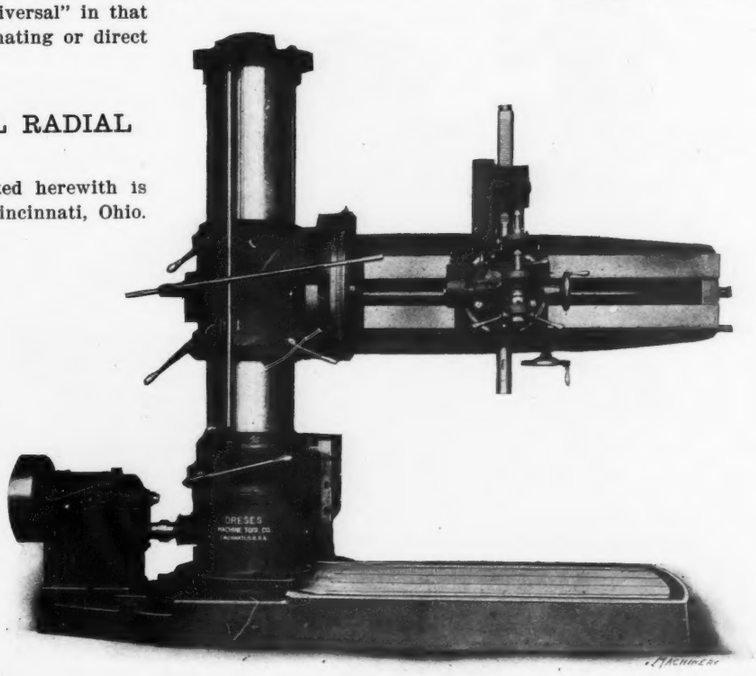
The six-foot universal radial drill illustrated herewith is a product of the Dreses Machine Tool Co., Cincinnati, Ohio. Referring to the illustration, it will be seen that the base is high and is provided with an oil groove running all the way around it. The oil drains into this groove which carries it away to a reservoir under the table. The outer column swings on a fixed inner column and both are made of particularly large size at the lower end to provide for the application of a roller bearing which supports the outer column. The inner column also carries an annular ball bearing at the top to insure an easy movement of the arm.

The arm is double webbed and strongly ribbed, and a shoe attached to the saddle and fitting between the two faces of the arm combines them into a solid box section when the saddle is clamped. The arm is lowered at twice the speed at which it is raised, and automatic knockouts are provided at either extreme of the travel. One of the special features of this machine consists of the design of the arm girdle. The socket which receives the arm is offset to one side of the center of the column to allow a long central shaft to be used in the head saddle and also to bring the spindle more nearly in line with the center of the column. The head is graduated for angular setting and can be swung through a complete circle.

The spindle is provided with twenty-one speeds and the quick advance and return mechanism has two handles, either of which instantly engages or disengages the feed. The feed mechanism is of novel design. A dial plate is provided on the feed shaft and makes one-quarter of a revolution for each revolution of the shaft, the movement of the dial being provided by means of planetary gearing and a pinion cut directly on the feed shaft. A fixed dog on the dial plate acts upon a lever and stops the feed automatically. There are eight changes of feed—four in a series—which are operated by the small handle on the left-hand side of the feed shaft, the number of feeds being multiplied by the horizontal handle above the handwheel.

The initial driving and speed mechanism is located at the rear of the arm girdle which simplifies the construction. The back gears are of the automobile transmission type, three changes being provided by means of the small lever at the front of the girdle which shifts the gears. The tapping, starting, stopping and reversing mechanism is of the friction type described in connection with one of this company's drills which was shown in the "New Machinery and Tools Section" of the November, 1911, number of MACHINERY. This mechanism is operated by the long telescopic lever which is always within reach of the workman. All of the gearing is completely enclosed and runs in oil.

The speed variator is of the well-known tumbler type; it has seven changes, and by means of a self-releasing overtake clutch the machine is run at the slowest speed when making changes in order to decrease the momentum and consequent shock as far as possible. All of the gears are hardened and the teeth are of the 20-degree involute pointed form to give added strength and to insure easy engagement. The pulley shaft has an annular ball bearing to reduce friction which would otherwise be very pronounced owing to the heavy lateral belt pull. All high-speed bearings are lined with removable bronze bushings and ball bearings are provided at points where the service is severe. Machines of this type



Dreses 6-foot Universal Radial Drill

are built in four-, five- and six-foot sizes and are furnished with cone, motor or speed variator drives to meet the requirements of different shops.

DIAMOND FACE GRINDING MACHINE

The grinding machine shown in the accompanying illustrations is a recent product of the Diamond Machine Co., Providence, R. I., and is particularly adapted for grinding railway locomotive guide bars. By using the face of the 30-inch ring wheel with which this machine is equipped, the entire surface of the guide is ground at each traverse of the table. The machine is also well suited for a variety of heavy surface grinding operations.

One of the most interesting features of this machine is the method by which the reciprocating motion of the table is obtained. The arrangement is similar to the familiar form of planer belt shifting mechanism, but has been modified to adapt it for use on a grinding machine. A three-step cone pulley fastened to the rear end of the spindle transmits power to an intermediate shaft on the right-hand side of the machine. From this intermediate shaft the drive is carried back to the left-hand side of the machine by means of two-inch open and crossed belts, which pass through the column to the table driving shaft. A detail of this construction is shown in Fig. 3, where it will be seen that two loose pulleys are arranged at each side of a tight pulley. So far the arrangement is similar to the planer drive, the distinctive feature lying in the fact that the dogs do not carry the shift of the belt but merely actuate the shifting mechanism. For this purpose a fourth pulley is loosely mounted on the table driving shaft, this pulley being driven from the intermediate shaft by means of an open belt. This pulley drives the spiral cam at its right-hand side by means of friction. When the tripping dogs come into action, the cam is released and carried through one-half revolution. During this movement the cam pulls over the lever which shifts the driving belts in the same way as on an ordinary planer drive. By this arrangement the shock of shifting is not felt by the table, and, at the same time, the operation of the mechanism is absolutely positive. The table drive is direct through a four-shaft reducing train.

The bed of the machine is of heavy construction and internally ribbed to give sufficient stiffness to prevent the slightest vibration when the machine is engaged upon heavy work. The ways are of ample proportions, a vee being used at the front and a flat bearing at the rear. The column is of the same form of ribbed construction as the bed, to which it is securely bolted. The table has five T-slots planed from the solid metal, and large runways are provided for draining away the water which is supplied to the wheel. The weight of the wheel-head is borne by the column ways, but its alignment is preserved by means of narrow inner ways. These ways have a taper gib and any play is taken up by means of a powerful spring. The machine may be arranged for belt drive from an overhead countershaft, for motor drive through a belt to the spindle, or for direct-connected motor drive.

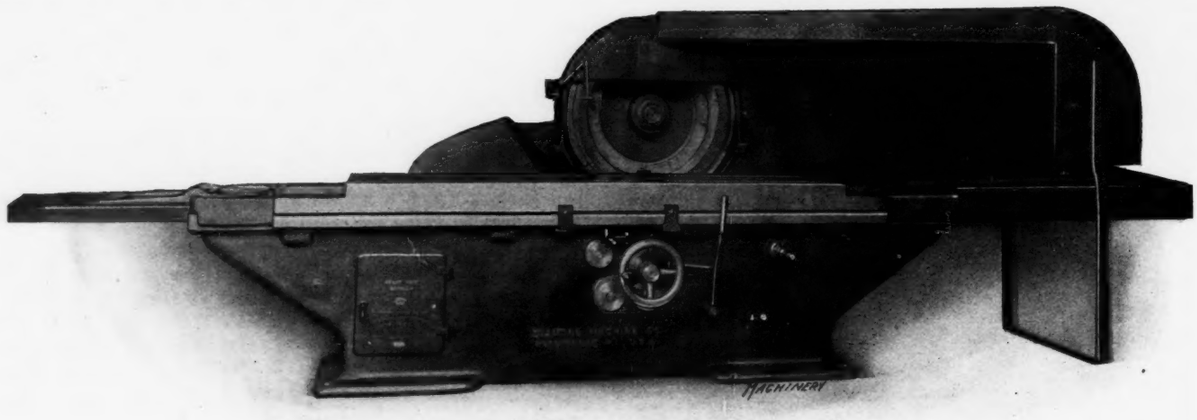


Fig. 1. Front View of Diamond Face Grinding Machine

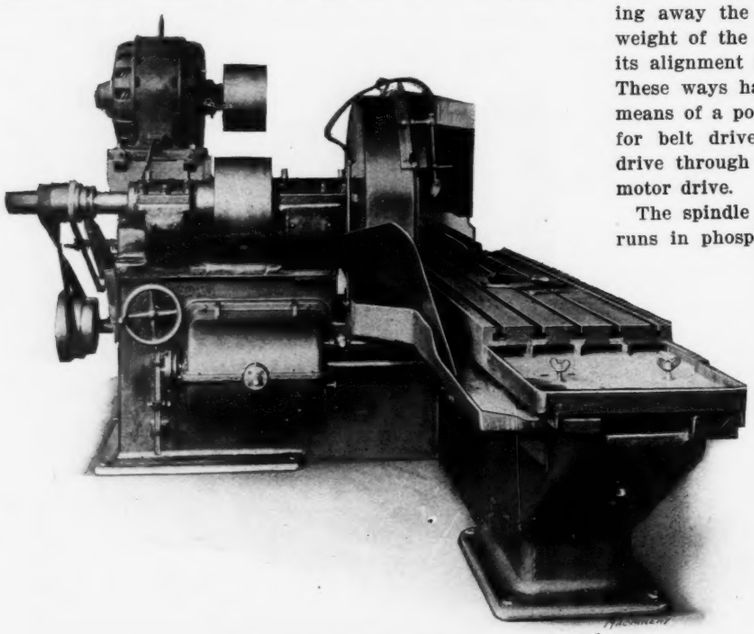


Fig. 2. Left-hand Side of Grinding Machine

The spindle is of 0.50 per cent carbon machine steel and runs in phosphor-bronze bushings which are cast in halves and provided with means for adjustment. These bearings are of ample size to insure permanent alignment. The thrust load is carried by a ball thrust bearing, and any end play which may develop is taken up by threaded collars. The wheel chuck is made of cast iron and carefully turned to insure perfect balance. The body of the chuck is tapered on the outside and slotted so that it may be compressed by a steel ring, which is drawn up on the taper by bolts to give the chuck a secure grip on the wheel. A backing plate, which is adjusted by means of studs, brings the wheel forward as it wears, and, in addition to serving this purpose, it affords additional support. A feature of this method of holding a ring wheel is that a narrow wheel, which removes the stock with less drag and heating, may be safely used.

Another feature of this machine is the provision for control from either the front or rear. This saves the time that is lost by the operator in walking around the machine or leaning over to watch the progress of the work. The customary procedure on work requiring a relatively long time for grinding is for the operator to place the work in position

and adjust the dogs for the required travel. He then goes around to the rear of the machine while the grinding is being done. Without the provision of control at the rear of the machine, it would be necessary to walk around to the front in order to stop the machine. The automatic feed is located at the rear of the machine, as this is the normal position for the operator when using this device. When two machines are used, they are usually placed back to back so that one operator can control both of them. The front and rear spindle bearings are lubricated by the ring-oiling system and the ways are grooved to facilitate oil travel. Oil pockets with broad rollers are also provided in the bed to insure efficient lubrication.

In face grinding the provision of an adequate supply of water for the wheel is of particular importance. The water performs three functions: it keeps the wheel clean so that it will cut freely at all times, it keeps the work cool and settles the dust. In order to provide an ample supply of water, this grinder is equipped with a centrifugal pump which is driven from the spindle by means of a cone pulley and belt. The stream of water is delivered diagonally onto the wheel, and the amount supplied can be adjusted to meet the requirements of different classes of work. It has already been mentioned that runways are provided in the table to carry away the water. These runways deliver it to troughs

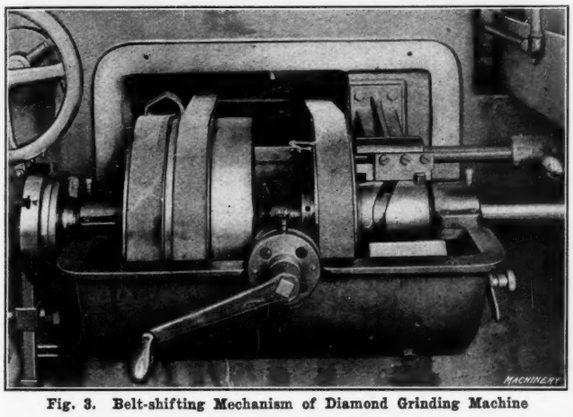


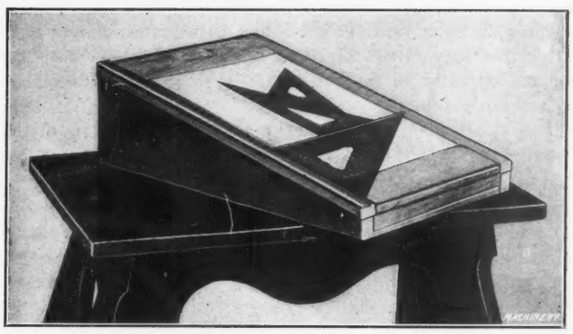
Fig. 3. Belt-shifting Mechanism of Diamond Grinding Machine

under the table from which the water flows into a settling tank where the emery and metal dust is removed. The clean water flows back to the main tank where it is ready to be delivered to the wheel as required. Water guards are fastened to the ends of the table and cover the ways at all times. A guard is also placed on the left-hand side of the machine; this guard is close to the hood and in front of the rear control, thus completely preventing the water being splashed onto the operator. The main water guard is located on the right of the machine and catches all water that is thrown off by the wheel. This guard empties into a water trough.

DOWD "NO-TACK" SKETCHING BOARD

An entirely new idea in the way of a drawing or sketching board is being placed on the market by Albert A. Dowd, Bridgeport, Conn., and the illustration shown herewith gives a general idea of its appearance. This board was primarily designed for the use of estimators, engineers, chief draftsmen, and tool designers, but it is also very convenient for others having occasion to make small drawings or free-hand sketches. A notable feature of the board is its freedom from obstructions of any kind, no thumb-tacks being necessary to hold the paper in position. This point will be appreciated by those using the ordinary type of small drawing board in which the protruding thumb-tack heads are a great nuisance, giving continual trouble by interfering with the free use of the T-square and triangles. No T-square is needed for this board, as the mahogany straightedge along the left-hand side is trued up along its inner side so that a large triangle may be placed against it, and used in place of the T-square. It will be noted by referring to the illustration, that the straightedge extends far enough below the end of the paper to insure a good bearing for the triangle, even when work is being done at the extreme lower edge.

The board is made in one size only, for drawings 9 by 12 inches or smaller, and the paper is carried on a roll underneath the upper end of the board or it may be used in small sheets if desired. Space is provided to accommodate a fifty-

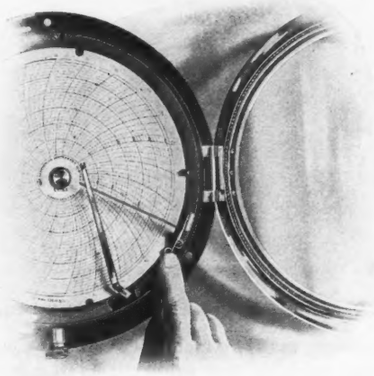


Dowd "No-Tack" Drawing Board for making Rapid Sketches

yard roll of paper. When it is used in the roll, the paper is pulled up through the spring actuated wing at the top of the board and drawn down across it and through the slot at the bottom, where there is another wing similar to that above. Rubber disks are inserted in the edges of these wings and they hold the paper in such a way that it may be stretched as tightly as a drum-head. The convenience of the board and the rapidity with which drawings and sketches may be made upon it are points which will find favor with those using it.

INDUSTRIAL PEN LIFTER

The Industrial Instrument Co., Foxboro, Mass., has just perfected a new attachment for use on the recording meters of its manufacture. This attachment is styled an automatic release pen lifter and is illustrated herewith. It is a simple device consisting of a strip of German silver pivoted on a holder, which is secured by one of the screws that holds the chart disk. By exerting a slight pressure on a small lever, this strip of German silver is raised and lifts the pen out of contact with the chart. The lifting device is held up by



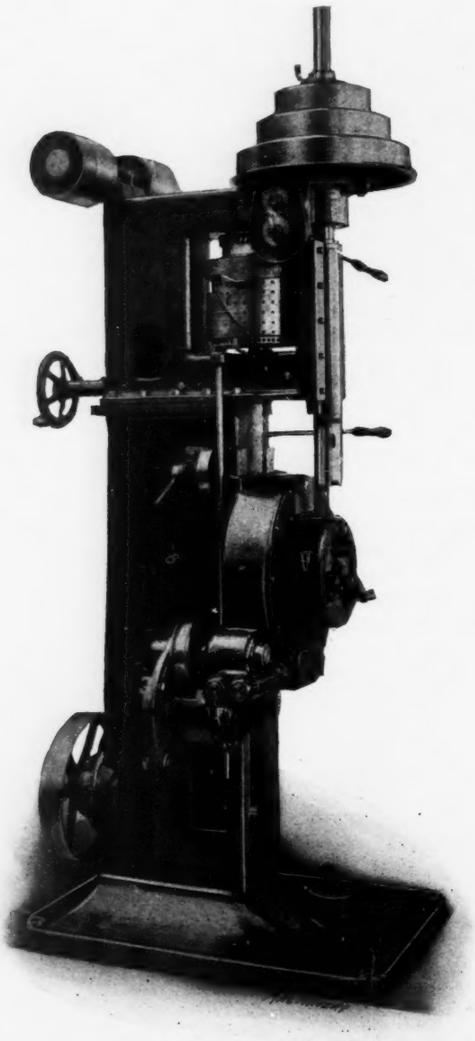
Pen Lifter for use on Industrial Recording Gages and Meters

friction, so that both of the operator's hands are left free to remove the chart and place a fresh one in its place. When the door of the meter is closed, the pen arm is automatically released and the pen returns to its marking position on the chart. This automatic feature makes it impossible for the operator to leave the instrument out of commission. In addition to the convenience of this attachment when changing charts, its use does away with the necessity of handling the pen arm, and the consequent danger of straining it and thus affecting the accuracy of the instrument.

BAKER AUTOMATIC DRILLING MACHINE

The accompanying illustration shows a development of the automatic drilling machine built by Baker Bros., Toledo, Ohio, which is intended for drilling radial holes in a flange or similar part. The operation of this machine is entirely automatic, the spindle being fed in to the work and returned by means of the cams located near the top of the machine, while the indexing is done by an index plate and change gears. Any number of divisions may be obtained. For this purpose it is, of course, necessary to set the change gears. After this adjustment has been made, it is merely necessary for the operator to remove the finished piece and replace it by a fresh blank.

The illustration shows the machine set up for drilling twenty-four radial holes in a flange, these holes being 7/16



Baker Bros. Automatic Drill for drilling Radial Holes in Flanges

inch in diameter by 7/16 inch deep. During a recent test to which this machine was subjected in the manufacturers' shops, the holes were drilled in a twenty-four hole flange in fifty-five seconds. From this it will be evident that the operation of the machine is very rapid, and the design is such that the holes are accurately spaced without requiring the use of a jig. The capacity of the machine is for flanges ranging from 3 to 24 inches in diameter. In addition to drilling radial holes in flanges and similar classes of work, the machine can be arranged to drill individual pieces held in a series of chucks mounted on the periphery of a disk. This machine is equipped with radial ball bearings which reduce friction and make it well adapted for operation at high speed.

NIAGARA FOLDER AND BENDING BRAKE

The folder and bending brake illustrated in Fig. 1 is a recent product of the Niagara Machine & Tool Works, Buffalo, N. Y. Examples of the bends which can be made on this machine are illustrated in Fig. 2, from which it will be seen that a large variety of work can be handled. Close edges can be turned for making lock seams and work with circular bends can be formed with equal facility. The machine can

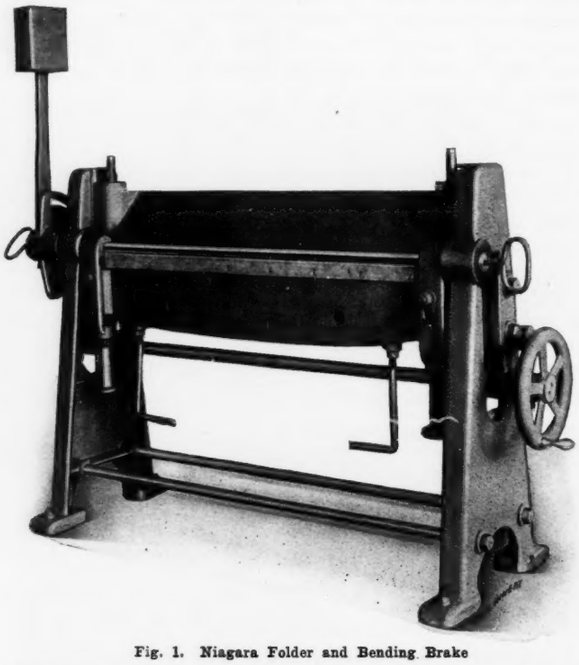


Fig. 1. Niagara Folder and Bending Brake

also be used as an ordinary bending brake, and tubes can be formed over a mandrel of suitable diameter. The production of circular bends is accomplished by mounting the folding and lower clamping bars in such a way they can be set up 2 inches below the folding axis. This adjustment is obtained by means of bevel gears and screws actuated by a hand-wheel, both ends of the clamping bar being adjusted at the same time. The ends of the folding bar are adjusted separately by means of screws. The upper clamping bar can be

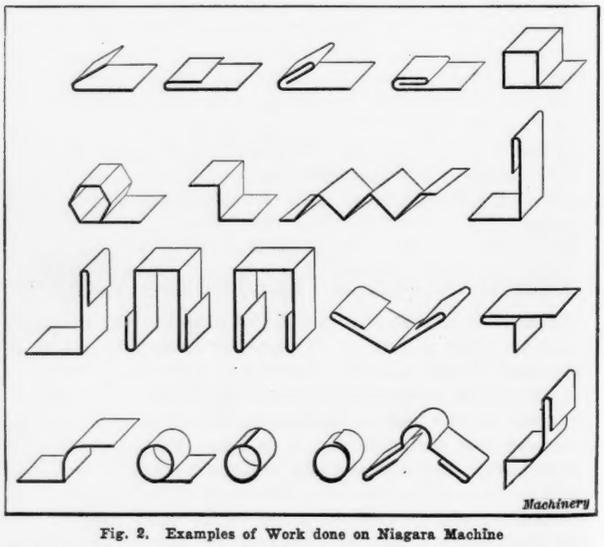


Fig. 2. Examples of Work done on Niagara Machine

raised to a height of 4 inches above the folding axis, thus affording ample space for a variety of sizes of mandrels about which the work is to be formed.

The construction of the machine is simple and rigid, the proportions being such that no tie-rods are necessary. A quadrant gage is provided at the left-hand end of the machine and is equipped with adjustable stops to regulate the motion

of the folding bar. The edge of the regular folding bar is ⅜ inch wide and a removable angle shaped bar is provided for forming heavy material. The folding bar is so attached to the upper clamping bar that it may be instantly removed.

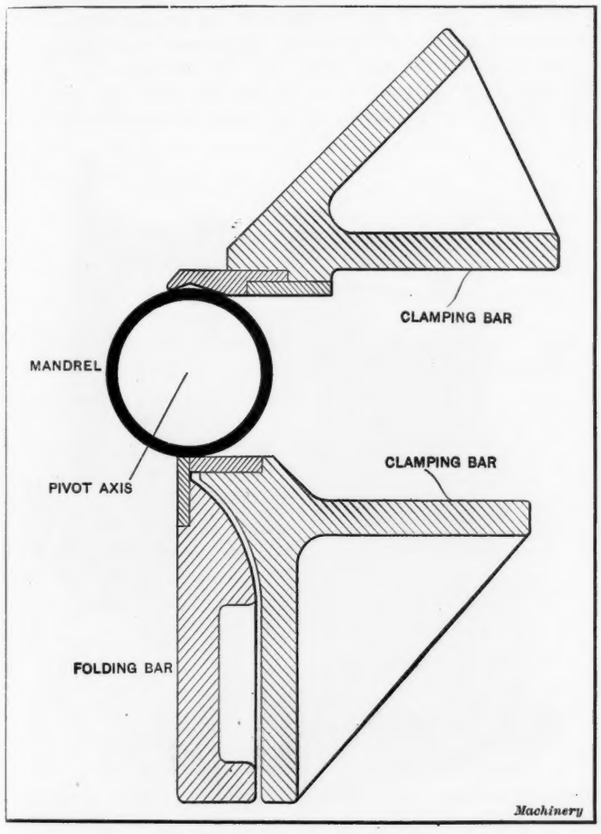
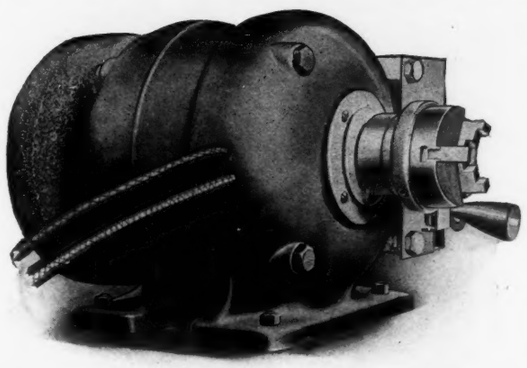


Fig. 3. Cross-sectional View through Clamping and Folding Bars arranged for Circular Bends

Using the ⅜-inch edge of the folding bar, the machine will handle stock up to 18 gage, while the use of the angle shaped bar increases the capacity up to 16 gage stock.

FORBES & MYERS POLISHING MACHINE

Forbes & Myers, Worcester, Mass., have recently added to their line the electrically driven polishing machine illustrated herewith. This machine is designed for finishing small parts which can be held in either a 2-inch scroll chuck or a ½-inch spring chuck with which the machine is equipped.



Forbes & Myers Combination Polishing, Grinding and Buffing Machine

The illustration shows the machine with a chuck at one end of the spindle and a small grinding wheel at the opposite end. This makes a useful form of equipment, but when so desired either a buffing wheel or a second chuck can be mounted in place of the grinding wheel.

The motor is of the same type that is used on the standard motor-driven grinders of this company's manufacture. It is of the squirrel-cage induction type and is capable of furnishing ½ horsepower intermittently, as in the case of ordinary polishing work. The motor is suitable for use on two or three phase sixty-cycle circuits of any voltage. The customary operating speed is 3600 revolutions per minute, but when so desired these machines are built with motors running at 1800 revolutions per minute. The motor is started or stopped by means of a switch lever, and in stopping, this lever applies a brake at the same time that it breaks the electric circuit. This automatic brake action adds greatly to the productive capacity of the machine, as it does away with the necessity of waiting for the spindle to come to a stop.

BROWN ELECTRIC PYROMETER

Fig. 1 shows an electric pyrometer for measuring temperatures up to 3300 degrees F., which has been brought out by the Brown Instrument Co., Philadelphia, Pa., and an instrument is shown in Fig. 2 with the case removed in order to give an idea of the construction of the mechanism. The distinctive features of this pyrometer are that the spindle which carries the indicating needle is mounted in jeweled

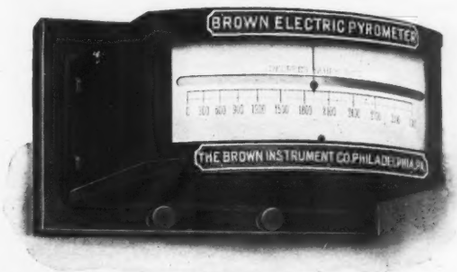


Fig. 1. High Resistance Type of Brown Electric Pyrometer

bearings and that the resistance of the instrument is made sufficiently high so that changes in the lengths of the leads running from the thermocouple to the instrument do not affect the accuracy of the indications.

The resistance of the instrument is about 100 ohms and changes of from 1 to 1000 feet in the lengths of the leads will not affect the indications as much as 5 degrees F. Changes in the temperature of the leads are also of no

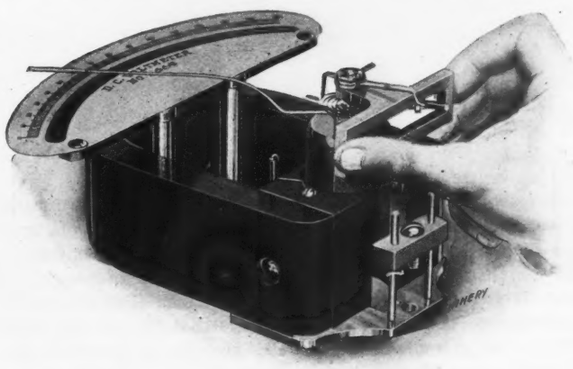


Fig. 2. Brown Pyrometer with Case removed to show the Mechanism

importance. This is due to the fact that the resistance of the instrument is very high as compared with the resistance of the leads. By having the moving element mounted in jeweled bearings, the instrument is also made more serviceable for shop use, as it is not easily damaged and does not have to be placed quite level in order to give accurate results. The scale is made of sufficient length to give the necessary interval between graduations and a mirror is provided under the scale in order to enable the needle to be lined up with its image. These two features facilitate making accurate readings.

OESTERLEIN UNIVERSAL AND PLAIN MILLING MACHINES

The universal and plain millers illustrated in Figs. 1 and 2 are representative members of a new line of milling machines which has been placed on the market by the Oesterlein Machine Co., Cincinnati, Ohio. They are known as "Ohio" milling machines and each style is built in five different sizes. One of the distinctive features of these machines lies in the fact that the heavy table and knee of the plain type of milling machine has been adapted for use on the universal machines. Practically the only difference between the plain and universal machines lies in the addition of the swivel saddle and table in the latter case. This arrangement has effected a great saving in the cost of production, as it is only necessary to provide jigs and fixtures for the manufacture of a single machine.

Universal milling machines are generally required to handle a variety of tool-room work. In order to adapt the present machines for this class of service, the construction has been worked out along lines which provide ample rigidity so that there is no vibration when taking heavy cuts on tool steel. As the ability to turn out work rapidly is proportional

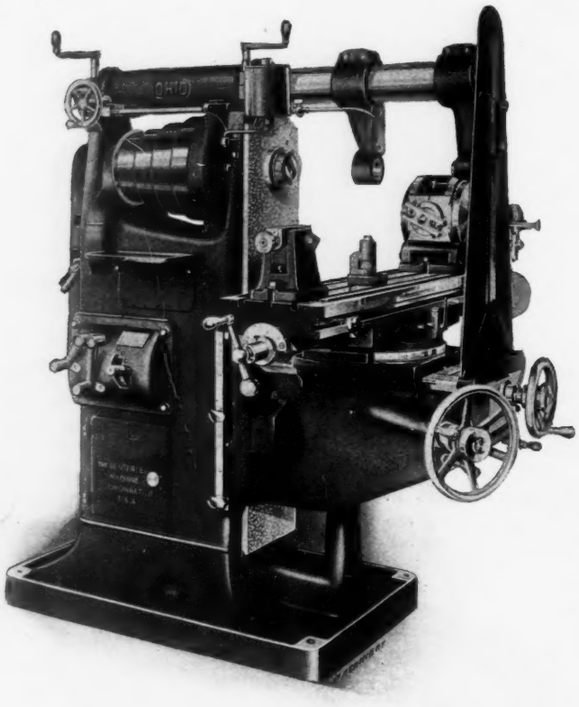


Fig. 1. Oesterlein Universal Milling Machine

to the amount of power delivered to the cutter, the provision of a cone with large belt contact, which is backed up by a construction of adequate rigidity, assures efficient operation and a high rate of output. In connection with the design of the universal machines, it may be mentioned that the swivel is clamped to the saddle in such a way that there is no possibility of movement. Oil pads and grooves are provided for lubricating the bearing surface of the swivel and table.

The plain milling machines of this line are essentially manufacturing machines. In order to make them well suited for this class of service, a number of features have been embodied in the design which add to the efficiency with which the machines operate. Among these, the belt shifting device which enables any speed to be instantly obtained is an important feature. The design of this belt shifting mechanism will be described in detail in a later paragraph, but it may be mentioned here that the method of operation is so simple that the workman will not hesitate to run his machine at the most suitable speed for the work upon which it is engaged.

Having touched upon the general characteristics of this line of milling machines and the distinctive features of the plain and universal types, a detailed description will now be given of different parts of the mechanism which are common to both the plain and universal machines. This can be conveniently done by following the course by which power is transmitted from the countershaft to the spindle and feed mechanism. Figs. 3 and 4 illustrate the arrangement of the cone-pulley and the countershaft, and clearly show the mechanism by which the belt is shifted. One complete turn of the handwheel on the machine shifts the belt from the center of one step on the cone-pulley to the center of the next step. A

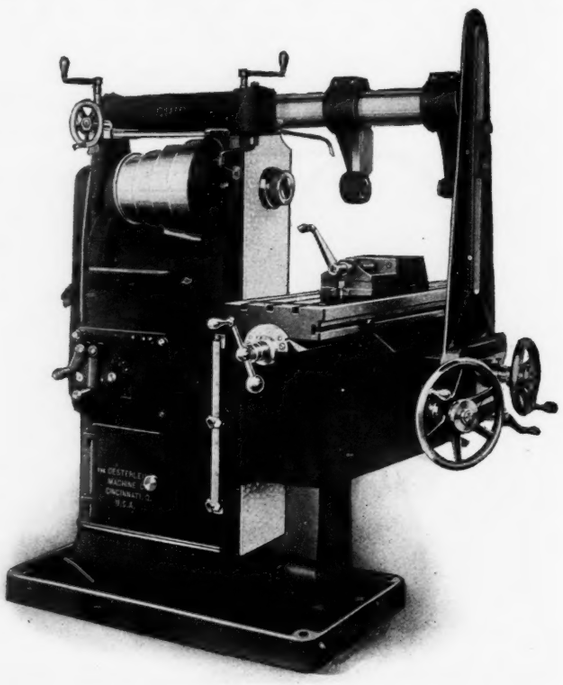


Fig. 2. Oesterlein Plain Milling Machine

simple lever equipped with a straight line motion shifts the belt to the desired position on the countershaft. By this means the required speed is obtained at once, without the necessity of making any intermediate changes. The operation of the mechanism is so simple that it is quite safe for an unskilled workman to make the change without any danger of damage to the machine. It will be noticed from the illustrations that there is but a slight difference in the diameter of adjacent steps on the cone pulley.

The spindle is made of special steel and runs in bronze journals which are lubricated by oil supplied from reservoirs

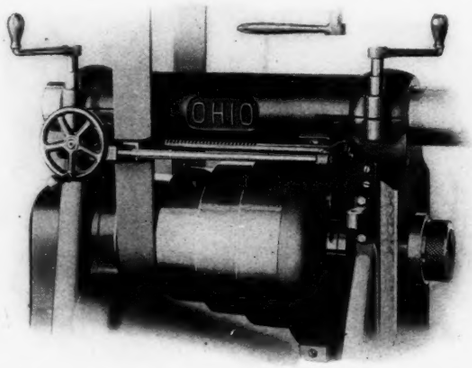


Fig. 3. Belt Shifting Mechanism on Oesterlein Millers

in the column. It will be noticed from the illustrations that the spindle nose is recessed, the purpose being to provide a positive drive for the cutter arbor. An adjustable bronze bearing 3 inches in length provides the front support for the arbor and an intermediate bracket is furnished for use when the machine is engaged upon extremely heavy cutting;

this bracket supports the arbor at a point close to the milling cutter. The back gear is mounted on a shaft inside the column of the machine. The gears are all cut with single-purpose, 14½-degree cutters which assures silent operation under all conditions.

The feed mechanism is driven from the spindle by means of a Diamond steel chain, the interior of the feed box being shown in Fig. 5. All gears and shafts in this box are of hardened steel and the shafts run in bronze bearings. The gears run in oil so that ample lubrication is assured. Two gears are keyed to the sprocket shaft and either of these gears can be engaged with the tumbler shaft. From this shaft, the drive is across the cone of gears to either sliding gear on the rear shaft, from which power is transmitted to the reverse gears in the knee by means of a universal joint. At this point, all of the feeds may be reversed by a lever on the front of the knee. The feed is carried from the knee through the saddle to the lead-screw.

A detailed view of the table and knee is shown in Fig. 6, from which it will be seen that the table has a bearing across

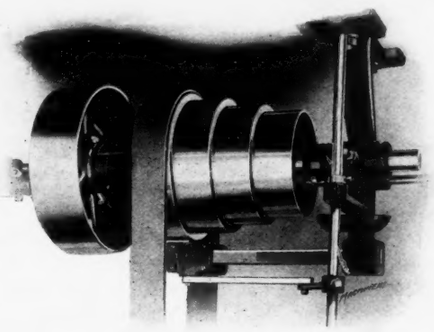


Fig. 4. Countershaft and Belt Shifter for Oesterlein Millers

its entire width. Ball bearings take the thrust of the table and means are provided for taking up any wear which may be developed in the table bearings. The table is supported by an exceptionally rigid saddle and knee, and as the construction is identical for both the plain and universal milling machines, the dividing head may be attached to either type of machine without disturbing the quick return mechanism.

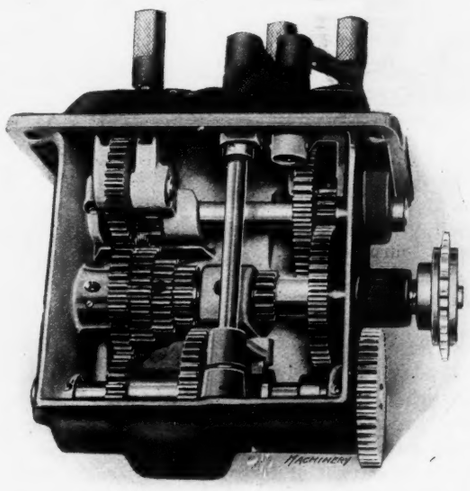


Fig. 5. Feed Box used on the Oesterlein Millers

Cross and vertical adjustments are made by means of handwheels that may be disengaged by means of clutch collars at the front of the wheels, so that the settings cannot be disturbed. Dials reading to 0.001 inch provide for accurate settings of the table and saddle. The knee is of heavy box section and stoutly ribbed to give adequate support to the table. When a setting is made, the knee may be locked to the column by means of a sliding taper gib which extends the entire length of the knee and is controlled from the front of the machine. The entire length and width of the table is used as a working surface.

The spiral dividing centers used on these machines are carefully tested before leaving the factory so that their accuracy is assured. The index crank is mounted directly on the worm-shaft instead of being connected by gearing. With-

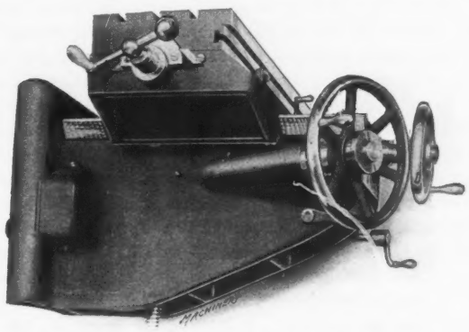


Fig. 6. Knee and Table of the Oesterlein Millers

out the use of tools, the spindle may be instantly freed so that it may be revolved by hand for direct indexing, the spacing being read by graduations on the flange of the spindle nose.

PEDRICK PORTABLE TURNING MACHINE

The illustrations show several applications of a portable turning machine which has recently been placed on the market by the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa. This machine may be used for a variety of purposes, among which turning crankpins of locomotives and other side crank engines; turning center crank-

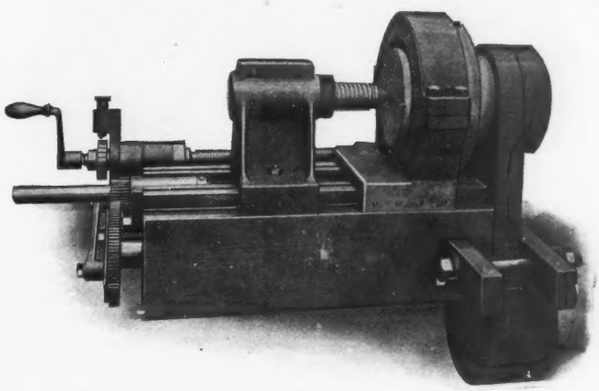


Fig. 1. Pedrick Machine set up for truing a Side Crankpin

pins, journals, shafts and axles, and reboring crankpin holes may be mentioned. In most cases, it is not necessary to remove a crankshaft or other piece from its regular position on an engine, in order to true it up on this machine.

Space is provided at the front end of the machine for clamping bars and other means of attachment to the work. The feed-screw is located at the back of the machine and is actuated by a ratchet and pawl mechanism of simple design. Variable and reversible automatic feeds are obtained. The crankshaft shown in the illustration provides for quick return of the cutter-slide and is also used for setting the tool against the work. The driving shaft is located beneath the cutter-head, where it is supported by bearings of ample dimensions. This position of the shaft permits a lighter construction to be used than would otherwise be possible and also adds to the convenience with which the drive may be taken from a motor mounted on a bracket attached to the frame of the machine.

The cutter-head is split to enable it to be put over the shaft or other member that is to be trued up while in position on a machine. The design of the cutter-head has been worked out in such a way that the split construction does not weaken it. The tailstock may be located at any point

along the bed to meet the requirements of different classes of work. When using the machine for reboring crankpin holes, the tailstock is placed in front of the cutter-head, in which position it affords a rigid guide for the boring-bar. The setting-heads are bored concentric with the center of the machine and are provided with set-screws by which the machine can be attached to an unworn part or set according to the center in the tailstock to secure the desired alignment. In cases where the work extends over the driving shaft so that a pulley cannot be used, the machine may be driven by a telescopic shaft with universal joints.

Five typical operations performed on this machine are shown in the accompanying illustrations. Fig. 1 shows the ordinary equipment used for truing up a side crankpin in its regular position. In this case, the movable tailstock with its adjustable center is placed in position, the adjustment of the tailstock adapting the machine for work of different lengths. Fig. 2 illustrates the machine set up for reboring crankpin holes after the crankpin has been removed. It will be seen that the tailstock is placed in front of the cutter-head. In this case, the cutter-head is only used to drive and feed the boring bar which is supported by the tailstock.

Fig. 3 shows the equipment used for truing up center crankpins. For this purpose, the mechanic lays off and drills centering holes for the pin on the outside of the cheeks of

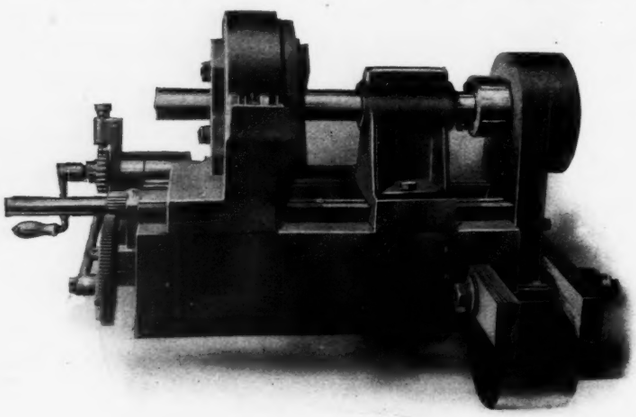


Fig. 2. Reboring Crankpin Hole on Pedrick Machine

the crank. The machine is then set up with two tailstocks which engage in these centering holes. Cutting tools can be used on either side of the cutter-head and where the distance between the cheeks is small, the cut may be started at the middle of the pin and run over to one side. The tools are then placed on the opposite side of the cutter-head and run across to the other cheek of the crankshaft.

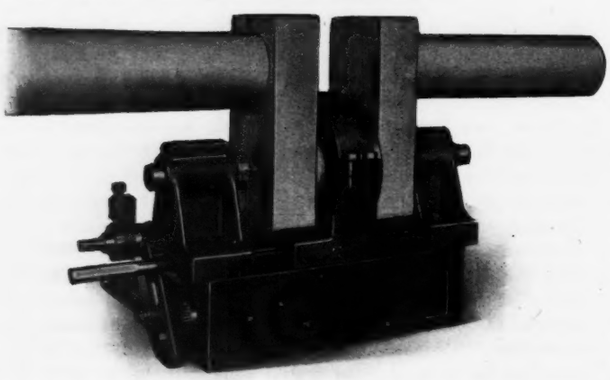


Fig. 3. Truing up a Center Crankpin

Fig. 4 shows the application of the machine for truing up large shafts, axles and similar parts. For this purpose, it will be seen that the machine is equipped with two setting-heads and a cutter-head. These three parts are all split so that they may be placed around the shaft regardless of any obstructions at either end. The machine may be fitted to the work by set-screws in the setting-heads or by making two sleeves with outside diameters the same as the diameter of the setting-heads and inside diameters the same as the shaft which is to be turned. In case the latter method is used, the sleeves are split and placed around the shaft, after which the machine is set up in the usual way. The setting-heads are bored concentric with the machine, thus providing the necessary alignment.

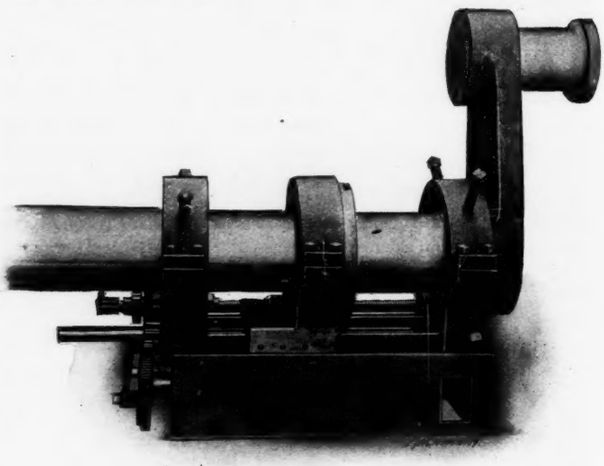


Fig. 4. Truing up a Large Shaft

Fig. 5 shows the arrangement employed for truing up the main bearing of an engine crankshaft or similar part. By referring to this illustration, it will be seen that the obstruction at either end of the shaft did not prevent the machine being used, due to the fact that setting- and cutter-heads are not slipped over the shaft, but placed around it. In some cases the machine will be worked upside down when there is not sufficient room for the bed of the machine between the pedestal and the crank-cheek or for similar reasons. This does not affect the accuracy of the work which is produced.

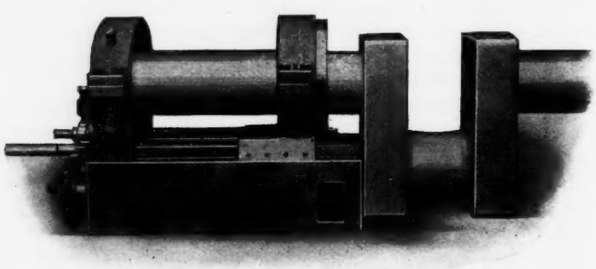


Fig. 5. Truing the Bearings of an Engine Crank

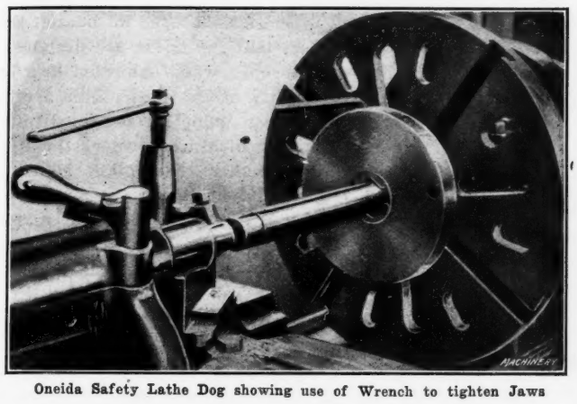
A study of the illustrations will doubtless suggest a variety of other purposes for which this machine is suitable, the illustrations merely showing a few typical operations for which it is adapted.

ONEIDA NATIONAL SAFETY LATHE DOG

The Oneida National Chuck Co., Oneida, N. Y., is now manufacturing the safety lathe dog illustrated herewith. This dog has been designed with the view of guarding all projecting parts, so that it is impossible for the operator's clothing to be caught or for him to be struck by set-screws, etc. This dog is made with hardened steel jaws which are tightened on the work by means of hardened steel adjusting screws. Two springs provide for opening the jaws when the screws are released.

The entire mechanism is enclosed in a pressed steel case, the construction being clearly shown in the illustration. This case is screwed onto the body of the dog and holes are provided through which the adjusting screws can be manipulated. These holes are large enough to admit the adjusting wrench but are not large enough to pass the screws, so that it is impossible for them to project through the cover. The driver is protected at the rear of the dog.

Two holes are provided through which the guard can be bolted to the lathe faceplate. This saves the time that would be lost in changing when duplicate parts are being machined, as the dog is held in a central position ready to receive successive pieces. This arrangement is the means of effecting



Oneida Safety Lathe Dog showing use of Wrench to tighten Jaws

a material saving of time in the production of repetition work. The assurance of safety afforded by this dog also adds to the normal rate of production of a workman as he is not kept on the "lookout" to prevent being injured.

NILSON TILTING WIRE REEL

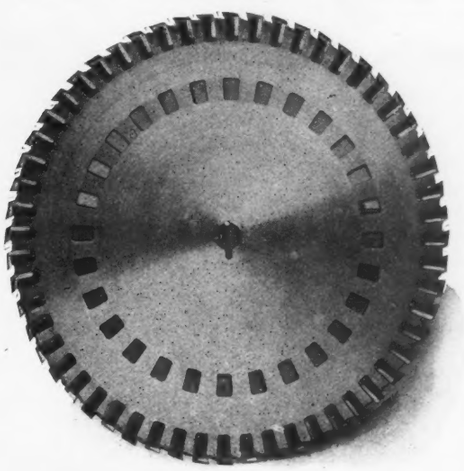
In using the ordinary type of wire reel in connection with wire-forming machines and presses, it is difficult to place heavy coils of wire on the coil-holder. This is due to the fact that the coil-holder is fixed in a horizontal plane and at a distance of two or three feet from the floor. In order to place a heavy coil of wire on the reel two men are generally required to lift it into the required position.

Nilson Wire Reel which facilitates placing Coils of Wire in Position

The A. H. Nilson Machine Co., Bridgeport, Conn., has brought out a reel which is designed to avoid these difficulties. Referring to the illustration, it will be seen that the standard which carries the reel is constructed in such a way that it can be tilted over to enable a coil of wire to be slipped onto the reel. When the reel is tilted over in this way, the coil can be rolled along the floor and put in place on the reel without requiring the services of more than one man. The illustration shows the reel on which a coil of wire has been mounted and the workman is about to lift it back into the operating position. When the reel is brought back to the vertical position it is automatically locked, and is thus ready for use. In order to tilt the reel over to put a new coil in place, the locking mechanism is released by means of a treadle which will be seen at the side of the machine close to the base.

HUNTER INSERTED TOOTH SAW BLADE

The Hunter Saw & Machine Co., Pittsburg, Pa., has recently brought out an inserted tooth saw blade suitable for use on sprocket-driven machines such as the Higley, Lea Simplex, and Lea-Courtenay machines. Heretofore this type of blade has not been adopted for use on sprocket-driven machines, owing to the fact that the teeth were so far apart that the operation of the machine was "jerky" when cutting the smaller sections. It was also considered impracticable to make a blade thick enough to withstand the strain at the sprocket holes and still operate without requiring the power of the machine to be increased. These objections have been overcome in the present design of blade, which has an ample number of teeth to insure smooth operation and is made



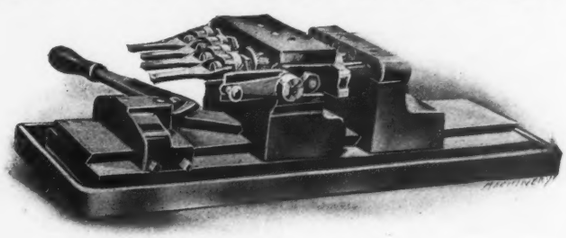
Hunter Inserted Tooth Saw Blade for Sprocket Drive Machines

thin enough so that the power required to drive the saw is not abnormal.

The body of the saw is made of heat-treated vanadium steel quenched in oil. This greatly reduces any chance of the tool pockets spreading or of the sprocket holes becoming distorted. The saw teeth are made of high-speed steel. A tool steel wedge is placed at the back of each tooth to hold it securely in place, and a brass screw is fitted in the body of the saw beneath each tooth to provide for regulating the height of the teeth. These saw blades are suitable for cutting structural steel, forgings, steel castings and a variety of other classes of work.

BICKFORD TAP FLUTING ATTACHMENT

The illustration shows a milling machine attachment for fluting machine screw taps which has been added to the line of the Bickford Machine Co., Greenfield, Mass. It will be seen that four taps are fluted simultaneously; the taps are



Bickford Milling Machine Attachment for fluting Machine Screw Taps

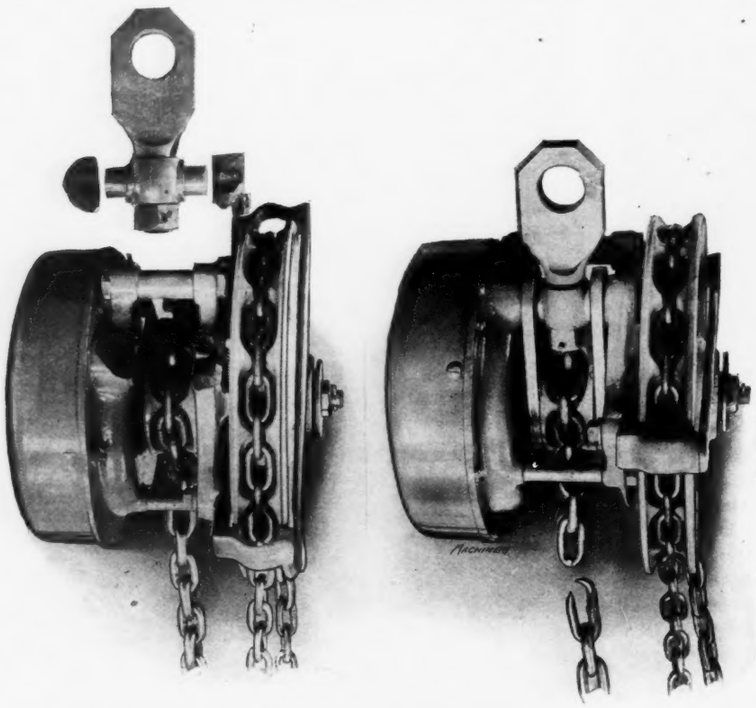
held in spring chucks with their point ends supported in bushings. The regular head center block is used and the indexing is accomplished by either a complete or a half turn of the crank.

The chucks are opened by raising the levers which are

seen projecting from the rear of the fixture. The head center block is operated by a lever after the taps are tightened in the chucks, thus bringing them into the bushings which are grooved to admit the fluting cutters. Small centers inside the spring chucks receive the end thrust. The attachment can be used on any milling machine.

YALE TRIPLEX BLOCK

Owing to the constantly increasing tendency to speed-up the work in manufacturing plants, the need of equipment of greater strength becomes more and more urgent. When working fast, the operators are bound to exercise less care and provision must be made to avoid accidents due to the failure of the equipment.



Figs. 1 and 2. Shock Tests on Cast-iron and Steel Blocks showing Relative Strength

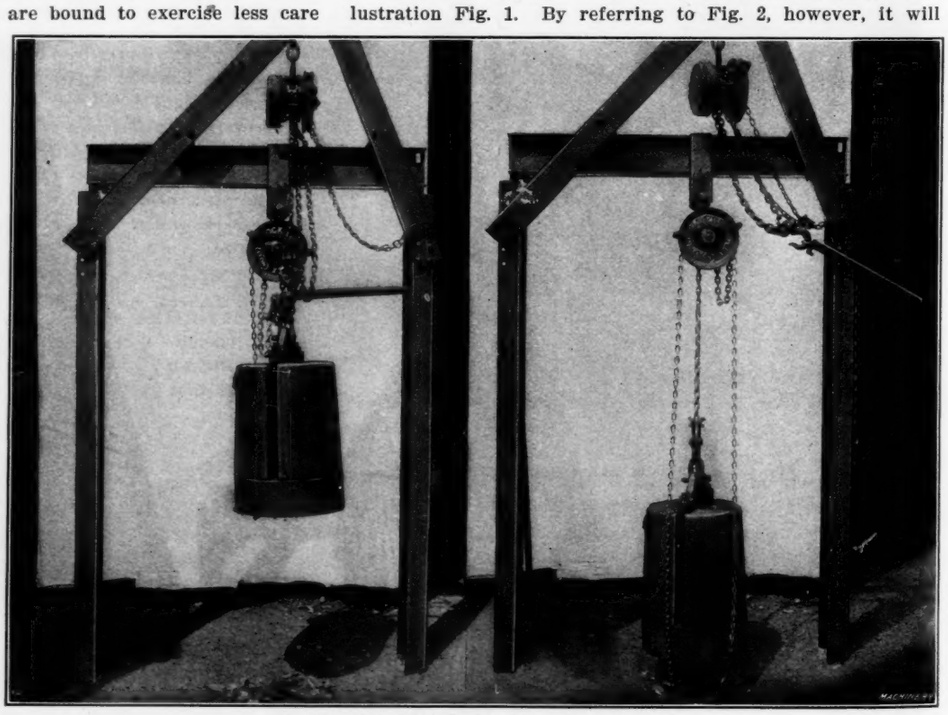
In order to obtain greater strength and safety in operation, the Yale & Towne Mfg. Co., 9 E. 40th St., New York City, has designed the Yale triplex hoist which is from hook to hook a line of steel. Fig. 1 shows a one-ton cast suspension block. This block was tested by raising a load of one ton on an auxiliary hoist and allowing it to drop in such a way that the shock came full upon the block. In the test illustrated, the load was dropped from a height of 16 inches and it will be seen that the cast-iron suspension member broke, although the chain is still intact. The Yale triplex block of steel construction is shown in Fig. 2. This block was tested in the manner previously described, and the one-ton load dropped from a height of 26 inches without injury to the gears and suspension plates. The only part affected was the load chain. This will withstand a drop test of 25 inches, however.

The method by which these tests are made is clearly illustrated in Figs. 3 and 4 where the arrangement of the auxiliary hoist and the location of the weight before and after the test are clearly shown. It will be seen that the top and bottom hooks were replaced by suspension eyes in making these tests. This is due to the fact that the hooks are designed in such a way that they start to open when subjected to a load of three times the rated capacity of the hoist. This arrangement has been adopted to constitute a safety device which will protect the equipment from damage that might be caused through careless operation.

The Yale & Towne Mfg. Co. has adopted the use of the long ton (2240 pounds) in rating hoisting equipment for two reasons. For equipment sold in the United States, ratings based upon the long ton are entirely satisfactory as such a rating merely affords a greater factor of safety. In England and several European countries, the long ton is in general use and consequently it is desirable to have equipment sold in such countries rated upon this basis. The mechanical efficiency of this hoist is such that a pull of 82 pounds by the workman is sufficient to lift 2000 pounds. In operating the hoist, 31 feet of chain are pulled through the block in order to lift the weight 1 foot.

NILSON FOUR-SLIDE WIRE FORMING MACHINE

In bringing out the new four-slide wire forming machine, the A. H. Nilson Machine Co. of Bridgeport, Conn., has incorporated a number of features new to this class of machinery. In general, the design of the machine is similar to that of other machines of this type, as will be noticed from the halftone illustration Fig. 1. By referring to Fig. 2, however, it will be seen that the distribution of the working members over the top of the frame is slightly different from the usual arrangement. The forming opening is at the center and



Figs. 3 and 4. Method of making the Shock Test

all of the forming slides are of the same length or practically so. On most other machines the right-hand and back slides are made considerably shorter owing to the fact that the feed, grip and cut-off mechanisms require so much room that the slide space is thrown over to the right and back of the machine. The slides are indicated at *A*, *B*, *C* and *D* in Fig. 2, and it will be seen that they have long and equal bearing surfaces. They are supported over their entire length by extensions from the bed. On each slide is cast an oil reservoir which furnishes a constant

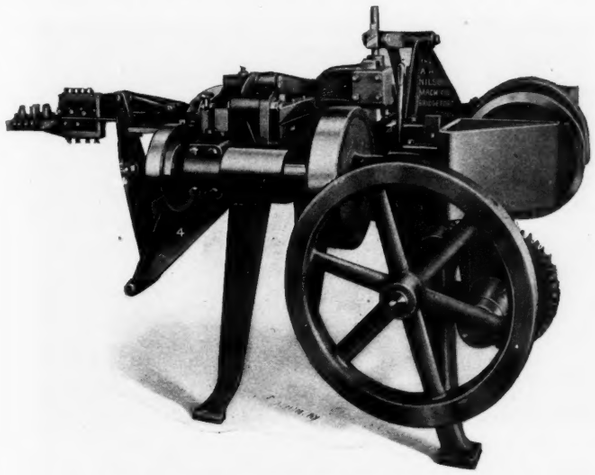


Fig. 1. Nilson Four-slide Wire Forming Machine

supply of lubricant for the cam roll studs. From Fig. 2 it will also be seen that the forces which act upon the wire line, namely, the feed, grip, etc., are as far as possible, in direct alignment; this is especially true of the feed itself. The wire line is indicated at *E*, and it will be seen that none of the forces that act upon it are far removed from this line. The feed will be described in detail later on.

Referring to Fig. 3, which shows the plan view of this machine, the idea of the central location of the four slides is clearly shown. As in other machines, the four cam-shafts are at the sides of the bed. The cams that operate

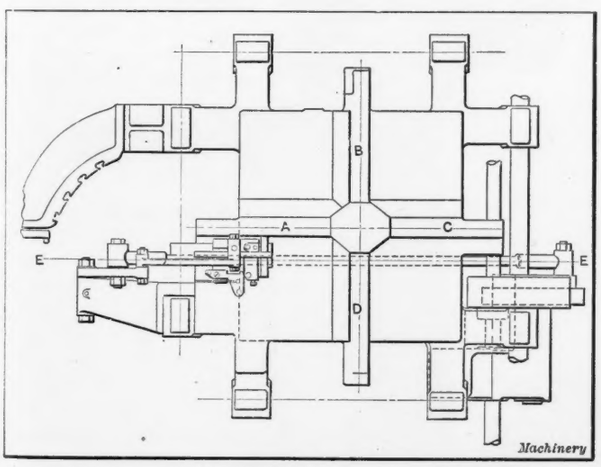


Fig. 2. Arrangement of Slides on Nilson Wire Forming Machine

the four slides of the Nilson machine are lined with tool steel plates, which give long wear and greater accuracy to the movements of the machine. The former bracket which is shown at the upper right-hand corner of the bed is particularly open in its design, being supported so that it overhangs the rear slides and does not in any way conflict with the adjustment or operation of the tools. The stripper lever, which is operated through the former, is carried on an independent bracket. Into this fits a block which holds the stripper pin. As the block is held in the yoke of the stripper lever, a better balance is secured, and the tools will operate with less vibration than with the old style of side connection. The stripper lever and bracket are illustrated in Fig. 5.

The grip and feed may be seen in Fig. 3, but they are best illustrated in Fig. 4. Here the feed operating rod is shown at *A;* this is the same rod that may be seen directly beneath the wire line, extending over to the right-hand side of the machine in Fig. 2. It should be especially noticed that this rod is in direct line with the wire; the rod is operated through a geared connection with the driving wheel which is shown in Fig. 1 at the lower right-hand corner. Instead of the offset bracket which is usually employed for operating the feed on wire forming machines, the Nilson machine uses a practically straight line lever shown at *B* in Fig. 4, whereby all cramping action of the old-time feed movement is eliminated. From this lever the force is transmitted to the

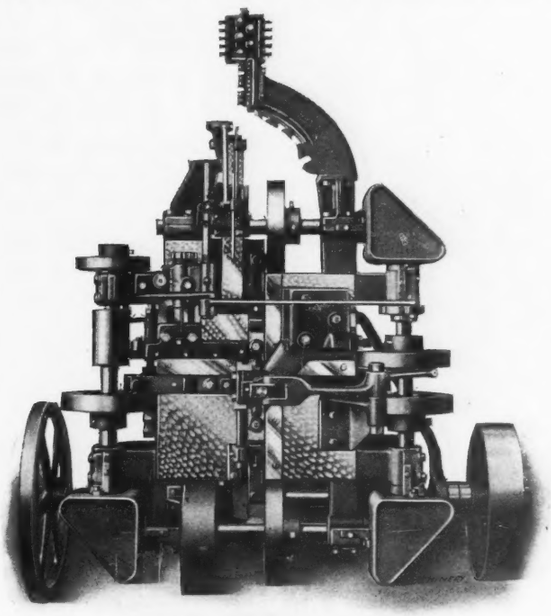


Fig. 3. Plan View of Wire Forming Machine

smaller lever *C*, which operates directly upon the wire-feeding mechanism. The feed finger *D* may be thrown out of engagement with the wire at any time by simply operating the spindle *E*, which is in an accessible position near the front of the machine. This feature of disengaging the wire feed with a plunger is quite novel. Upon the cut-off bracket is mounted the gripping lever that may be seen extending over to the rear cam-shaft of the machine. The cam on this shaft operates the gripping mechanism in the usual manner. The cut-off adjustment is secured in a very satisfactory way by means of a handwheel, which may be seen at the left of

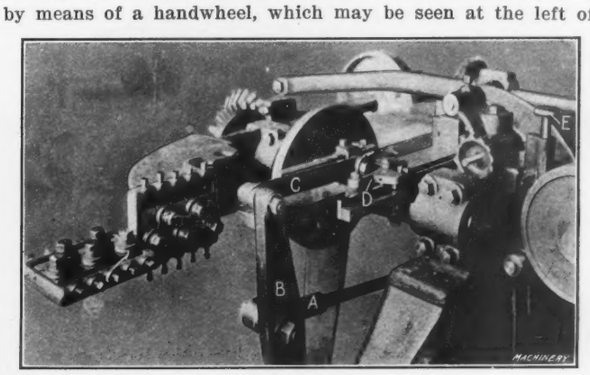


Fig. 4. View of Gripping and Feed Mechanism

the bracket. This handwheel operates the screw so that a very close adjustment of the feed may be obtained without resorting to guesswork.

Another interesting feature is the lever by which the cut-off blade is operated. Cut-off movements on wire forming machines have usually been unsatisfactory because the action

given to the cut-off blade has not been in line with the action of the tool. The cut-off must necessarily be above the line of the cam-shaft. This means that a bent cut-off slide and inefficient movement had to be used. The cut-off mechanism of the Nilson machine is clearly shown in Fig. 6. Here the cut-off slide is shown at *A*, and the operating cam at *B*. The operating cam, however, does not act directly on the cut-off slide, but its motion is transmitted to the arm *C*, which receives the motion at its lower end and transmits it from a point about half way up, to the end of the cut-off slide. The cut-off slide is brought back after its operation by means of the arm *D* which is operated from the opposite side of the cut-off cam. This arm serves as a confining member, making the lever *C* positive in its action. The cut-off slide is kept in contact with lever *C* by means of a stiff spiral spring. These machines are built in seven standard sizes, which form wire from 1/32 inch to ½ inch in diameter, and have a capacity for wire lengths from 4½ to 22 inches.

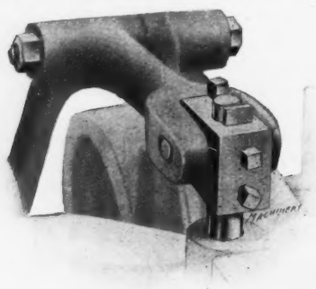


Fig. 5. Detail of Stripper Lever and Bracket

GARRIGUS NO. 2 HAND MILLING MACHINE

The illustrations show a machine known as the No. 2 Bristol miller which has recently been placed on the market by the C. G. Garrigus Machine Co., Bristol, Conn. This machine is adapted for a variety of milling operations on small work, among which may be mentioned: hobbing worm-wheels, profiling, cam cutting and keyseating. Such work is conveniently handled on a hand milling machine and the provision of both lever and crank feed on the present machine adds to its convenience of operation.

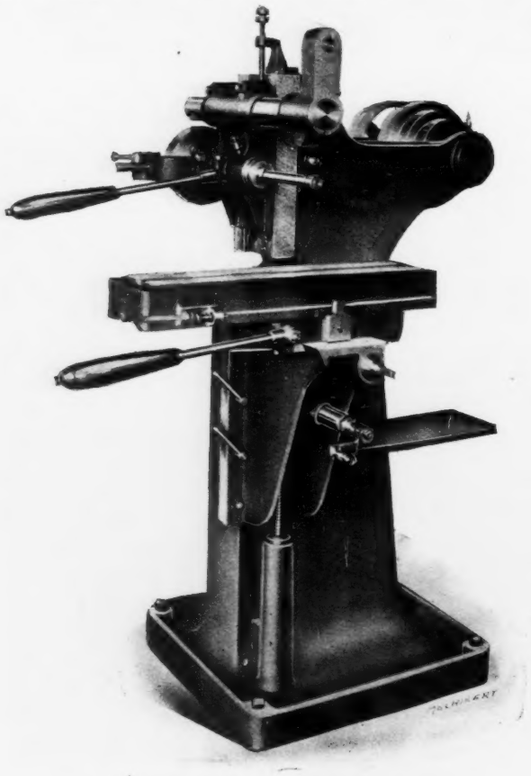


Fig. 1. Garrigus No. 2 Hand Milling Machine

The following gives a brief outline of the features of the design of this machine. The spindle has double tapers at each end, and adjustment for wear is made by means of check-nuts which are capable of compensating for any amount of wear which the machine may develop. The spindle bearing is bronze-bushed and a reservoir which holds one-half pint of oil is located at the center of the bushing, thus insuring adequate lubrication. The geared head on the spindle provides ample power for the heaviest cuts that a machine of this size will be called upon to handle. The cone pulley back-shaft is fitted with New Departure double-row

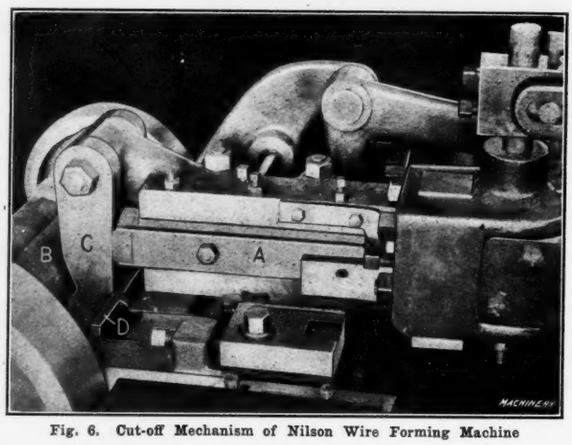


Fig. 6. Cut-off Mechanism of Nilson Wire Forming Machine

combined radial and thrust bearings. The machine is furnished either with or without power feed.

The distance from the center of the spindle to the under side of the arm is 3⅞ inches, and the distance from the end of the spindle to the center in the arm is 12 inches. The spindle has either No. 9 B. & S. taper or No. 3 Morse taper. There are six changes of spindle speed. The maximum lever feed is 6 inches and the maximum crank feed is 18 inches. The table is 7 by 25 inches in size and has one T-slot ⅝ inch wide. The maximum distance from the top of the table to the center of the spindle is 17 inches. The transverse movement of the table is 6½ inches. The machine

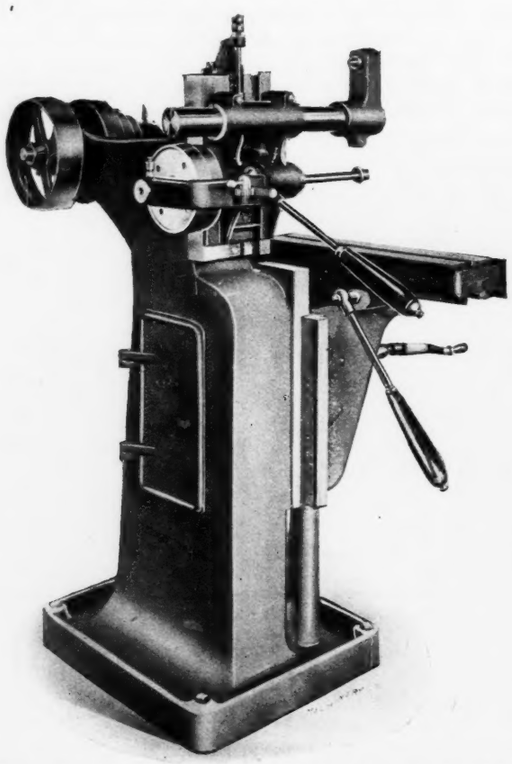


Fig. 2. Rear View of Garrigus Miller showing Arrangement of Drive

occupies a floor space of 30 by 46 inches and weighs 1112 pounds.

CINCINNATI GEAR CUTTER GRINDER

The illustrations show front and rear views of a gear cutter grinder for formed cutters which is a recent product of

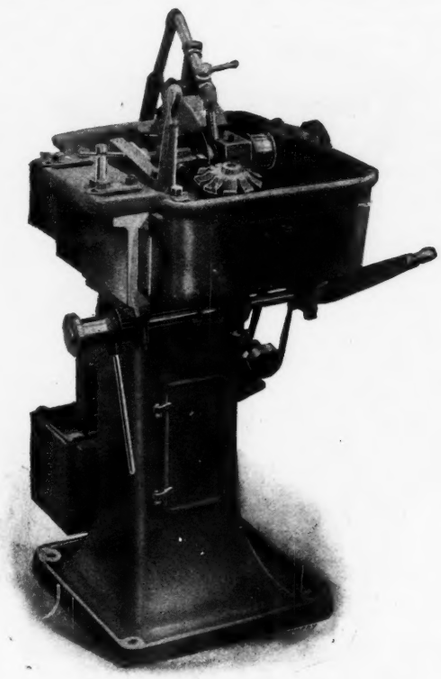


Fig. 1. Front View of Cincinnati Gear Cutter Grinder

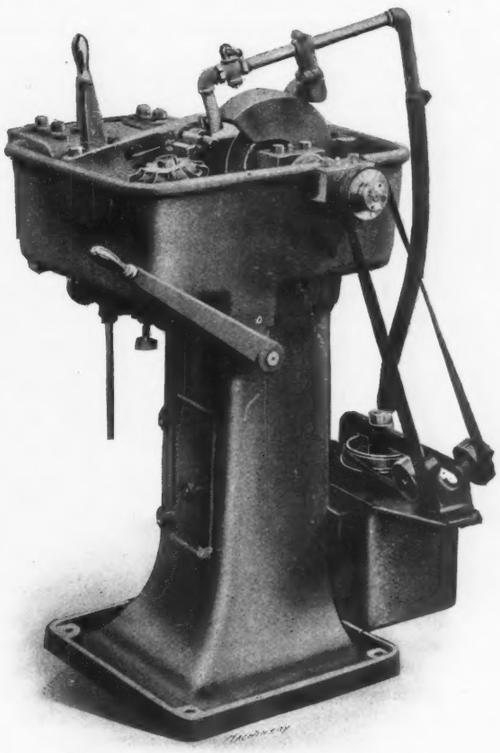


Fig. 2. Rear View of Cincinnati Gear Cutter Grinder

the Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio. It is a well-known fact that formed cutters for cutting gear teeth must be ground so that the axis of the cutter lies in the plane of each of the tooth faces, and it is to provide for grinding these radial faces of the teeth that this machine has been designed. The principal claims made for the construction are simplicity and the fact that the work-slide is located outside of the pan so that it is not exposed to damage from water and grit.

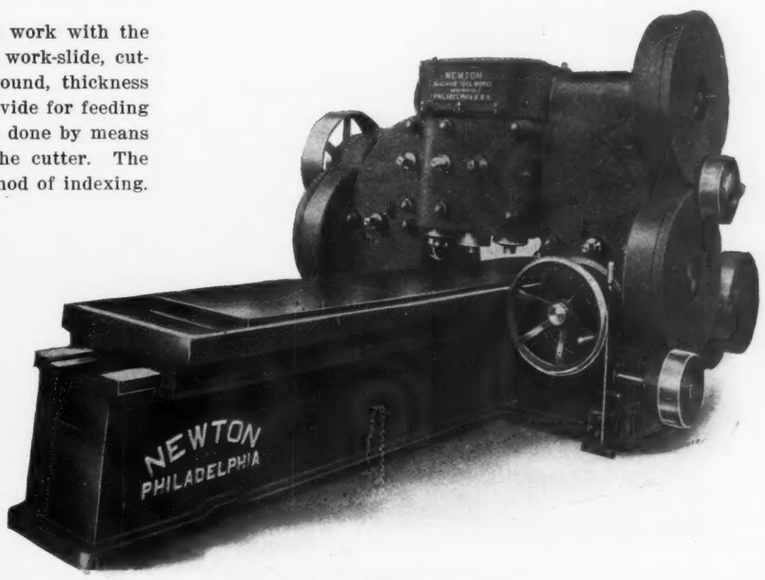
Adjustments are provided for centering the work with the wheel, and for regulating the position of the work-slide, cutter diameter, depth to which the tooth is ground, thickness of the cut, inclination of the cutter, and to provide for feeding the cutter to the grinding wheel. Indexing is done by means of a pawl which bears against the heel of the cutter. The following advantages are claimed for this method of indexing. It is not complicated, can be rapidly effected, it is not necessary to secure the cutter to its arbor by means of clamping nuts and consequently the cutter can be instantly removed for gaging or inspection, and inaccuracies in the cutters due to hardening or other causes may be corrected.

The work-spindle is hardened and ground and runs in bronze bushings that are carefully protected from grit and provided with means of adjusting for wear. The work-slide has a long bearing on the pan of the machine and is provided with a taper gib for taking up wear. The machine is equipped with a wheel truing device for keeping the grinding face of the wheel accurate. Water is supplied to the wheel by means of a centrifugal pump, which draws the water from a reservoir to which it is delivered from the settling tank, where emery dust and grindings are removed.

The machine is driven from a countershaft which has tight and loose pulleys 8 inches in diameter by 2¼ inches face, the countershaft being driven at 350 R. P. M. The machine occupies a floor space of 31 inches by 41 inches and the total weight of the machine and countershaft is 1200 pounds. The capacity is for cutters up to 10 inches in diameter and 1 diametral pitch.

NEWTON FIVE-SPINDLE MILLING MACHINE

The illustration shows a five-spindle milling machine which has been added to the line of the Newton Machine Tool



Newton Five-spindle Milling Machine

Works, Inc., Philadelphia, Pa. The machine is of simple design and has a powerful drive for the spindles which insures a high rate of output at a low maintenance cost. The drive for all of the spindles is taken from a single pulley

which is mounted on a shaft extending through the machine. The right- and left-hand spindles are driven from this shaft by means of spur gears, while the three vertical spindles are driven by spiral gears. Each of the spindles has a double taper bearing in its sleeve, and hand adjustments are provided for each of these sleeves which are held in position by means of binding bolts.

The work table is provided with an angular rack and spiral gear drive. Only one change of gear feed is available at any time, but additional changes can be made by using different gears. The table is 24 inches wide and long enough to provide for milling work 12 feet in length. The machine has a capacity for handling work 24 inches in width by 4½ inches high and uses milling cutters up to 5 inches in diameter. The feed is taken from the end of the main driving shaft and motion for the quick return is taken direct from the countershaft to the pulley which drives the quick-return mechanism. Hand adjustment of the table is provided and the engagement of the feed and fast power traverse is controlled by a single lever.

The weight of the machine is 22,000 pounds. While such a powerful machine may appear unnecessary for the light work for which it is intended, experience has shown that more accurate work and heavier feeds are possible on such a machine and that this justifies the additional expenditure for heavy equipment.

ROCKFORD TWENTY-INCH DRILL

The illustrations show the right- and left-hand sides of a new 20-inch vertical drill press which has been added to the line of the Rockford Drilling Machine Co., Rockford, Ill. The distinctive features of this machine are briefly described by the following: It will be seen that a star feed handle is used in place of the lever which was previously applied to the machines of this company's manufacture. This handle consists of a central clutch member, which, when thrown into the outer position, acts directly on the cross spindle to provide a quick approach or return of the tool. When thrown into the inner position, a gear is engaged which operates with a train of four reduction gears to provide a slow movement for heavy drilling or facing operations.

Fig. 1. Right-hand Side of Rockford Drill showing Star Feed Handle

Another distinctive feature consists of the dial which acts as a trip for the power feed. This dial is graduated to correspond with graduations on the sleeve and a small trip dog is mounted on it, which can be readily moved to any desired position, where it is secured by means of a thumbscrew. When the required depth of drilling is reached this trip engages a roll shown on the yoke casting in Fig. 2 and throws it upward, thereby disengaging the power feed. It will be seen that all gears are thoroughly incased. The worm-wheel is guarded from beneath and this guard forms a well for holding lubricating oil.

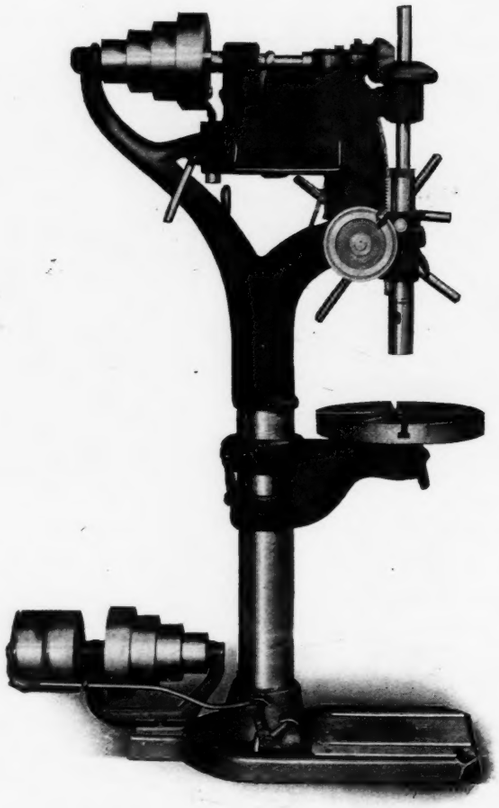


Fig. 2. Left-hand Side of Rockford Drill showing Dial Feed Trip

NEW MACHINERY AND TOOLS NOTES

Traveling Crane Trolley: Shaw Electric Crane Co., Muskegon, Mich. A traveling crane trolley particularly adapted for steel mill service. The trolley is constructed entirely of steel.

Releasing Chuck: Manufacturers' Equipment Co., Chicago, Ill. A releasing chuck designed to hold threaded pieces. This chuck eliminates the necessity of stopping or reversing the machine in chucking or removing the work.

Hand Drill: Millers Falls Mfg. Co., 28 Warren St., New York City. A two-speed hand drill with gear ratios of 1½ to 1 and 4 to 1. The change of speed is made instantaneously by means of a clutch mechanism on the drill.

Pillar Crane: Production Engineering Co., Philadelphia, Pa. A crane designed to be carried by one of the pillars in an industrial plant. The arm can be swung in a complete circle around the pillar. The crane is equipped with a chain-block hoist and is adapted for all classes of light lifting.

Center Grinder: Paul Spiegel, 234 E. 117th St., New York City. A lathe center grinder consisting of a swinging bracket attached to the front of the head. The grinder spindle is driven by a friction wheel engaging with one of the steps of the cone pulley, the speed being increased through suitable gearing.

Pneumatic Hammer: Chicago Pneumatic Tool Co., Chicago, Ill. A pneumatic riveting hammer equipped with a safety device. This device consists of a knurled nosepiece screwed over the end of the cylinder. The cup end of the rivet set projects through an opening in the nosepiece, which holds the rivet set in place.

Vertical Miller: Becker Milling Machine Co., Hyde Park, Mass. A vertical milling machine in which the movement of the head is controlled by a worm and worm-wheel, an automatic stop being provided for throwing out the feed. A quick hand return is also provided, and the depth of cut is accurately determined by means of a micrometer gage.

Boring Mill: H. Bickford & Co., Lakeport, N. H. A seven-foot motor-driven boring mill equipped with a ten-horsepower variable-speed motor. The machine is driven direct through a gear-box, which, in conjunction with the variable-speed motor, gives thirty-six table speeds. Work 84 inches in diameter by 48 inches high can be handled.

Forming Press: Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio. A hydraulic press for forming articles out of sheet metal. This press has three cylinders, the middle cylinder operating the blank-holder while the cylinders at each side operate the forming platen. The press has a capacity for pressures up to 68 tons and will handle work up to 38 by 38 inches in size.

Coupler Shear and Riveter: Watson-Stillman Co., 192 Fulton St., New York City. A hydraulic car-coupler shear and riveter in which the cylinder is an integral part of the body of the machine. The main casting is pivoted to a stand on its back face, instead of being bolted to the stand from the bottom. This permits the casting to be swung around to meet the requirements of different classes of work.

Combination Lathe and Grinder: Cincinnati Precision Lathe Co., Cincinnati, Ohio. This company has modified the design of its friction head bench lathes to adapt them for cutter grinding. When engaged on cutter grinding operations, the tooth-rest bracket is bolted to the swivel head or to the bed of the machine, according to the requirements of different classes of work. The grinding wheel is mounted on the tool-slide in the usual way.

Horizontal Miller: Becker Milling Machine Co., Hyde Park, Mass. A horizontal milling machine driven by a constant-speed pulley which adapts the machine for belting direct to the lineshaft. The gear-box is placed between the constant-speed pulley and the pulley to which the spindle is belted. Twenty-one spindle speeds are available ranging from 8 to 375 revolutions per minute. The feeds are obtained through friction disks, feeds ranging from 0.003 to 0.600 inch per revolution being available.

* * *

BROACHING HEAVY BENCH VISE BODIES

The ordinary machinists' bench vise with front sliding jaw fixed on a rectangular section bar offers, in the back jaw, a first-class broaching job. A common practice has been to cast the back jaws with the rectangular opening cored as closely as possible to the required size and to fit the sliding jaw bar to it by filing. The result, of course, is considerable hand labor and more or less unsatisfactory work in many cases. The application of the broaching machine enables the vise manufacturer to cast the back jaws with smaller openings and to remove metal all around the inside of the hole with the broach. This insures perfect bearing and working surfaces free from hard scale.

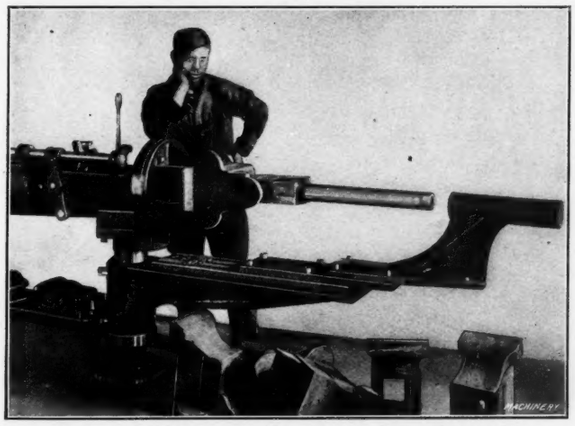


Fig. 1. J. N. Lapointe Machine broaching Heavy Vise Body

The accompanying illustration Fig. 1 shows an equipment recently furnished by the J. N. Lapointe Co., New London, Conn., to a vise manufacturer for broaching the holes in heavy vises. The chief feature of interest, aside from the general operation, is the means provided for supporting the heavy broach. The broach weighs 275 pounds and is, therefore, entirely too heavy and dangerous a tool to be lifted by hand. The necessity of handling the broach at each operation is neatly avoided. The broach is provided with a round shank at the rear, which telescopes into a supporting bracket, The bracket holds it up in line with the pulling shaft and thus eliminates the necessity of the operator's handling it. The round shank enables the broach to be turned readily to clean off the chips.

The jaw of the vise shown in the illustration weighs about 150 pounds. It is mounted for broaching with the broach in the position shown in Fig. 2, and the broach is then slipped up over the pulling shaft which projects out of the machine and is connected with the key shown lying on top. As soon as the machine begins to pull the broach through the vise jaw, the teeth come in contact with the metal all around and by the time the support shank of the broach leaves the support bracket at the rear the pressure developed is sufficient to hold the broach and vise jaw up in position. The bracket for supporting the broach is pivoted on the round column beneath the end of the machine bed, and can be swung around beside the bed out of the way when the machine is being used on lighter broaching work.

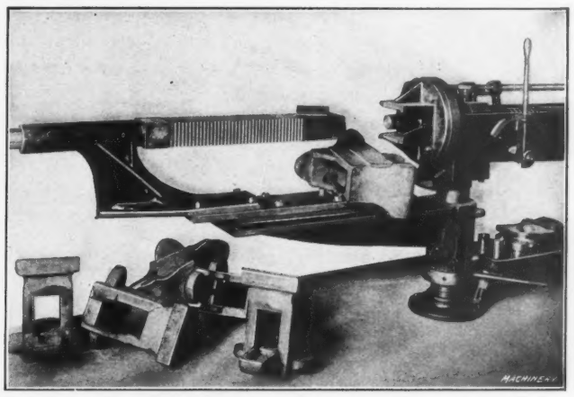


Fig. 2. Showing Heavy Broach supported on Bracket ready for placing Work in Position

This broach is believed by the makers to be the heaviest ever made and used. The time required for broaching a jaw depends, of course, on the activity of the operator, being perhaps from four to five minutes apiece.

* * *

EIGHTH ANNUAL CONVENTION OF TRADE PRESS ASSOCIATION

The eighth annual convention of the Federation of Trade Press Associations was held at the Hotel Astor, New York City, September 18–20. The program included a large number of short papers and addresses on advertising, editorial policy, circulation, publishing, etc. The object of the Federation is to bring about better business methods and a higher conception of ideals in trade paper publishing, to increase the efficiency of trade papers as advertising mediums and to raise the standards of the business generally. Friday evening, September 19, was given over to the annual banquet at the Hotel Astor which was attended by several hundred men, many of whom are prominently connected with trade paper publication.

* * *

The report of the Interstate Commerce Commission for the year ending June 30, 1912, states that the aggregate mileage of railway tracks of all kinds was 360,714.24 miles. This mileage was classified: Single track, 240,238.81; second track, 24,929.51; third track, 2511.76; fourth, fifth and sixth tracks, 1783.97; odd tracks and sidings, 91,250.19 miles. The number of locomotives in service was 61,250 of which 14,206 were classified as passenger, 36,600 as freight, 9475 as switching and 969 were unclassified.

MACHINE FOR MAKING "WELDED SEAMLESS" TUBING

Mr. Marshall B. Lloyd of the Lloyd Mfg. Co., Menominee, Mich., is the inventor of a new process for manufacturing "seamless welded" metal tubing. Front and rear views of the machine used for this purpose are shown in the accompanying illustrations; the machine is of a very compact design, only occupying a floor space of 3 by 20 feet. Double machines for producing two tubes simultaneously are also built, such machines requiring the attention of two operators.

The method by which stock is fed to the machine is clearly illustrated in Fig. 1. Either hot- or cold-rolled steel is used; the material is fed into one end of the machine and the finished tubing comes out at the other end. The operation of the machine is entirely automatic, the operations of forming, welding, straightening, sizing, polishing and cutting off being performed without any attention from the operator. The capacity of a single machine is for 4000 feet of tubing per day, regardless of the size of the tubing which is produced.

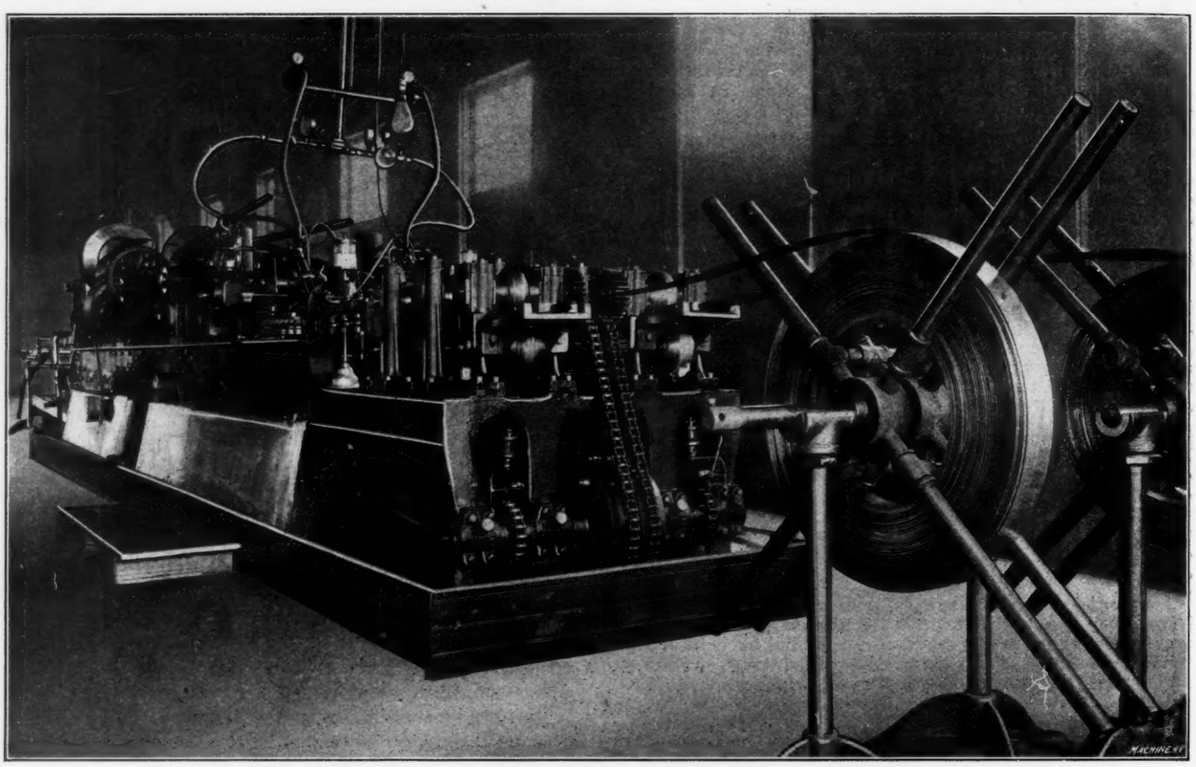


Fig. 1. Front View of Lloyd Machine for making "Welded Seamless" Tubing showing Delivery of Stock to the Machine

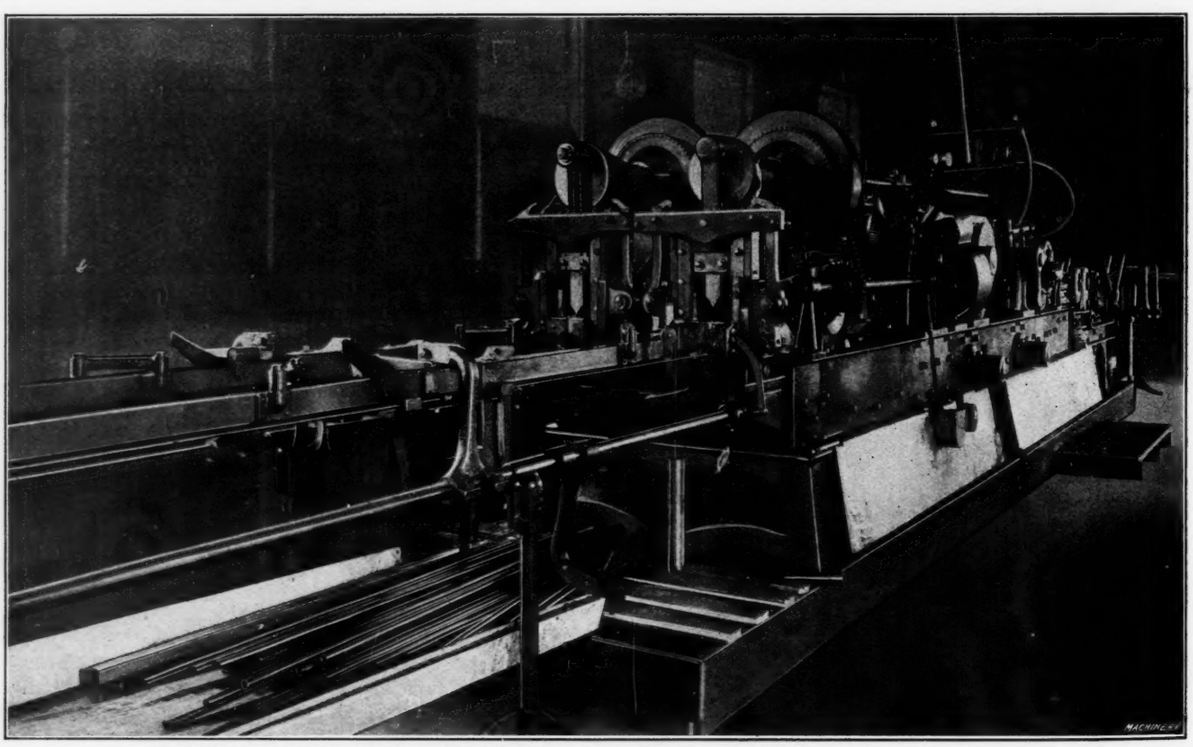


Fig. 2. Rear View of Machine for making "Welded Seamless" Tubing, showing Finished Tubes made in the Machine

The machine is very economical in the use of stock, the only waste consisting of about 1/16 of an inch of material at

each point where a finished tube is cut off. Anyone familiar with the process of manufacturing tubing will appreciate the fact that this is far more economical than other methods which are in common use. In producing drawn tubing, the thinner that the walls of the tube are required to be, the greater the expense of production, owing to the increased amount of power that is necessary during the drawing operation. With the Lloyd process, walls of a given thickness are obtained by using the proper gage of metal so that the cost of production is not affected. Practically any desired shape of tube can be made, among which may be mentioned such standard forms as oval, round, square or hexagonal. No additional expense is involved in the production of irregular shapes.

The machine has a capacity for producing tubing from one to seven inches in diameter and special machines could be built for producing larger sizes. The method of operating the machine is quite simple and consequently no extended experience in tube making is necessary in order to produce satisfactory work. The method of threading the ends of tubing produced on this machine is to build them onto the ends of the tube rather than to cut threads in the walls of the tubing. By this means, the threaded section can be made of any desired strength.

The operation of the machine may be briefly outlined as follows: The flat metal strip is drawn through a series of small rolls which form it to the required shape around a suitable mandrel of special construction. After passing through this process, the edges of the tube are close together ready for the welding operation. An autogenous welding torch is used for this purpose which joins the seam of the tube by the familiar process of fusion welding. A thin burr shows on the metal at the point where the weld was made but this defect is removed by a knife on the machine. The tube is next smoothed down with a fine emery wheel.

After these operations have been completed, the tube passes on to a powerful vise equipped with semicircular jaws. This vise has a reciprocating movement through a distance of two feet and draws the tubing through the machine at each forward movement. When the tube leaves the vise, it is sized and polished by a process of cold rolling with water. After this operation has been completed, the tube goes through the straightening device and is then cut off and dropped into a receptacle at the end of the machine. This end of the machine is clearly illustrated in Fig. 2. It is stated that the tubing produced in this way is so smooth and bright that it has the appearance of having been electroplated.

* * *

LARGEST PRECISION TESTING MACHINE

The U. S. Bureau of Standards, Washington, D. C., lately installed a testing machine for testing columns, blocks, beams, girders and other shapes of steel, iron, wood, concrete, reinforced concrete, etc. The machine measures the breaking strength, spring under load, etc. It has a capacity for specimens of any length up to 34 feet and is capable of exerting a pull of 1,150,000 pounds and a compression of 2,300,000 pounds. Although of such great capacity, the claim is made that the mechanism is so delicate that the pressure of a finger on the ram will be registered.

* * *

PERSONALS

Forrest R. Jones, formerly head of the department of machine design at the University of Wisconsin and later with Cornell University, has taken charge of the editing of data sheets known as "Lefax" published by the Standard Corporation, Philadelphia.

Otto E. Kleinert, for the past twenty-five years general foreman of the automatic and tool departments of the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has resigned to become superintendent of the King Machine Co.'s works in Bridgeport, Conn.

Col. George W. Goethals, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has accepted the honorary presidency of the International Engineering Congress, and will preside in person over the general sessions to be held in San Francisco September 20–25, 1915.

Lawrence W. Cady, formerly electrical engineer for the Browning Engineering Co., of Cleveland, Ohio, is now engaged in consulting and designing work. Mr. Cady is a specialist on the design and application of electrically-operated machines. His address is 1557 Robinwood Ave., Lakewood, Ohio.

George L. Colburn, for the past three years assistant to Frank Burgess, proprietor and general manager of the Boston Gear Works, Norfolk Downs, Mass., is now mechanical engineer with the Holmes & Blanchard Co., builders and dealers in crushing, grinding, sifting and mixing machinery. Mr. Colburn is also associated with George Vincent Rogers, president of the company, who conducts a large factory appraisal business, established in 1893.

Axel F. Backlin, mechanical engineer with the American Steel & Wire Co., Worcester, Mass., and assistant to the late Fred H. Daniels, was tendered a farewell dinner by the Swedish Engineers' Society of which he is president, at the Bancroft Hotel, Worcester, September 20. Mr. Backlin has been transferred to the Pittsburg office of the American Steel & Wire Co., as assistant superintendent. He will act, in a sense, as master mechanic for the company.

D. De Vries, a well-known machine tool specialist, employed by R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, will visit the United States in October in the interest of his concern, which is actively engaged in selling American machine tools. Mr. De Vries has just returned from a trip to the far East, where he spent four months in Java, establishing agencies for the sale of American machine tools, and making demonstrations, etc. His work attracted favorable attention from government and railway officials. Mr. De Vries will visit the United States especially in the interest of his firm's Eastern machine tool business.

Prof. A. Riebe, director of the Riebe Kugellager und Werkzeug Fabrik, Berlin, Germany, arrived in New York, September 18, on the steamer *Imperator* to visit his American agents, Olin, Giberson & Lowy, 30 Church St. Prof. Riebe, who in conjunction with Prof. Stribeck made many original investigations into the design of radial ball bearings, will deliver several illustrated lectures while in America before the various sections of the Society of Automobile Engineers. The lecture before the metropolitan section was given on September 25, the subject being "A Review of the Inception of the Ball Bearing and Roller Bearing and their Application in the Automobile Industry."

* * *

OBITUARIES

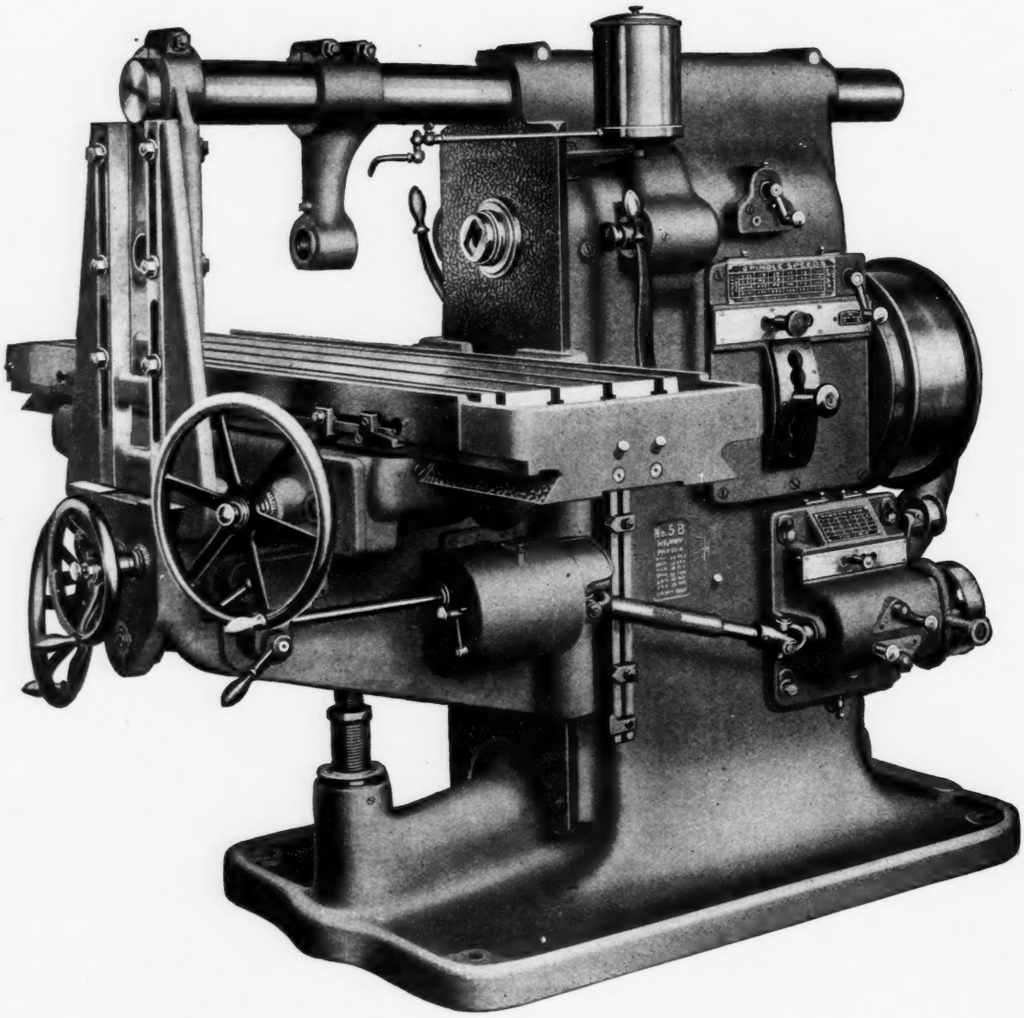
Thurston M. Phetteplace, professor of mechanical engineering of Brown University, Providence, died at the Maine General Hospital September 7, aged thirty-six years, following an operation for carbuncle. Prof. Phetteplace was a member of the A. S. M. E. and had contributed valuable papers to its proceedings. His untimely death will be mourned by all knowing his abilities.

Howard F. Martin, general sales manager of the Eveland Engineering & Mfg. Co., Philadelphia, Pa., was killed in a railroad accident near North Haven, Conn., September 2. Mr. Martin was returning with his wife, from a vacation in Maine and she, too, was killed. Mr. Martin was forty-five years old and had been connected with the Pennsylvania Steel Co., for about fifteen years as purchasing agent and sales manager. After resigning his position as sales manager with the Pennsylvania Steel Co., which he had held for about ten years, he went with the Eveland Engineering & Mfg. Co. in a similar capacity. He was a member of several leading clubs and other organizations of Philadelphia, and was also a member of a number of steel trade organizations.

George W. Bennett, vice-president and general manager of the Willys-Overland Co., Toledo, Ohio, died September 19, aged forty-nine years. He was born in Worthing, England, and came to America at an early age. He was assistant manager of Gormully & Jeffrey Mfg. Co., of Chicago, from 1885 to 1892. In 1892 he became branch manager of the company at Washington, D. C., remaining there until 1895. From Washington he went to Brooklyn, N. Y., for the same company, leaving in 1899 to become Eastern representative of the American Bicycle Co. of New York. From 1900 to 1906 he was sales manager for the Thomas B. Jeffrey Co. of Kenosha, Wis., and in 1906 manager of the Knox Automobile Co. of Springfield, Mass. He then became Eastern representative of the White Co., remaining in this position until 1910, when he went to Toledo to join the Overland forces. Mr. Bennett was a member of many national and international organizations connected with the automobile trade, including the Automobile Board of Trade. He is survived by a widow and two sons.

Fred H. Daniels, chief engineer of the American Steel & Wire Co., Worcester, Mass., died at his home in Worcester August 31, aged sixty years. Mr. Daniels was a well-known mechanical engineer and was chairman of the board of engi-

MEETS REQUIREMENTS



No. 5 B Heavy Plain Milling Machine

Capacity 50" x 12" x 21".

BROWN & SHARPE MFG. CO.,

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 429 University Block, Syracuse, N. Y.

REPRESENTATIVES: Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis, Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore.

FOR HEAVY SERVICE

What do you expect in any machine designed for heavy manufacturing service?

Above all, ample power and a consistently rigid design.

Note how well these points have been taken care of in the No. 5-B Heavy Plain Milling Machine.

Large diameter constant speed drive pulley running at high speed carries an extra wide belt. The overhead pulley is also of large diameter giving wide belt contact and powerful driving leverage. The variable feed, by means of hardened spur gears, is driven by chain direct, mounted on large diameter hardened steel shafts, firmly supported. Result—elimination of vibration, and maximum efficiency.

The knee slide extends to the top of the frame, stiffening the column and forming a massive housing for the spindle. Notice the long bearing of the knee on the column. Stout transverse ribs give rigidity for heavy service.

The table is heavy and has a vertical depth that gives the necessary stiffness to prevent springing under deep cuts. The depth of the saddle and extra long bearings in proportion to the length of the table are clearly shown.

Stout, easily adjustable braces serve to firmly lock the knee and overhanging arm together, resisting the stresses that tend to produce vibration.

If you have heavy milling, these features should interest you.

Better ask us now for full particulars.

Study the Cut

PROVIDENCE, R. I., U. S. A.

CANADIAN AGENTS: The Canadian-Fairbanks-Morse Co., Ltd., Montreal, Toronto, Winnipeg, Calgary, Vancouver, St. John, Saskatoon.

FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt a/M., Germany. V. Lowener, Copenhagen, Denmark, Stockholm, Sweden, Christiania, Norway; Schuchardt & Schutte, St. Petersburg, Russia; Fenwick Freres & Co., Paris, France; Liege, Belgium, Turin, Italy, Zurich, Switzerland, Barcelona, Spain; F. W. Horne, Tokio, Japan; L. A. Vail, Melbourne, Australia; F. L. Strong, Manila, P. I

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neers of the United States Steel Corporation. He was a graduate of Worcester Polytechnic Institute, and entered the employ of the Washburn & Moen Co. immediately after graduation as a draftsman. His skill and ability as a draftsman and designer soon won recognition and he was sent abroad several times to obtain plans and data for the development of the plant. When Charles H. Morgan retired from the company in 1887, Mr. Philip W. Moen was made superintendent and Mr. Daniels, assistant superintendent. Mr. Daniels became general superintendent after a year's service as assistant general superintendent. When the thirty big steel and wire manufacturing plants of the country were consolidated by John W. Gates in 1896 under the name of the American Steel & Wire Co., he was given the responsibility of putting a number of run-down plants in first-class condition. Mr. Daniels was the inventor of about 150 improvements in wire drawing machinery, etc.

Frank B. Rutter, second vice-president and sales manager of the Scranton Bolt & Nut Co., Scranton, Pa., was killed in a railroad wreck near North Haven, Conn., September 2, while a passenger on the Bar Harbor express which was telescoped by the White Mountain express. Mr. Rutter was forty-one years old. He was born in Lykens, Dauphin Co., Pa., and was educated in the public schools of Lebanon, Pa., from which he entered the employ of the Pennsylvania Bolt & Nut Co., now the American Iron & Steel Mfg. Co. He started as an office boy and served for a time as clerk in the rolling mills and from there was transferred to the estimating department of the general offices of the company. After working several years in that department he was chosen teller of the First National Bank of Lebanon, in which capacity he served for four years with marked ability. He left this position in 1903 to take a position as chief clerk of the accounting department of the Scranton Bolt & Nut Co., and in 1905 was promoted to president in the sales department. In 1906 he was made sales manager and in 1910 was chosen a director of the company, which position he filled with ability until his death. Mr. Rutter was a man of unusual character and ideals. He was a member of the Manufacturers' Club of New York City, the Pennsylvania Society of New York, Engineers' Society of Northeastern Pennsylvania, the Scranton Club and the Country Club of Scranton. In 1908 he married Miss Grace B. Law, daughter of A. F. Law, president of the Temple Iron Co. Mrs. Rutter also lost her life in the wreck.

SOCIETIES, SCHOOLS AND COLLEGES

University of Manchester, Manchester, England. Prospectus of University courses, session 1913-14; also illustrations of the school, laboratories, workshops, and departments for bleaching, dyeing, printing and finishing textile goods and manufacturing paper.

American Museum of Safety, 29 W. 39th St., New York City, has made a special report on lead poisoning and the report is considered of so much value by Dr. C. F. Stokes, surgeon-general of the U. S. Navy, that a lengthy abstract with illustrations will be published in the "U. S. Medical Bulletin."

Pratt Institute, Brooklyn, N. Y., will begin evening courses in mechanical drawing and machine design, October 1. Other courses offered are technical chemistry, industrial electricity, practical electricity, steam engines, strength of materials, practical mathematics, trade teaching, machine work, toolmaking, carpentry and building, patternmaking, and sheet metal work.

COMING EVENTS

October 7-10.—Convention of American Society of Municipal Improvements in Wilmington, Del. George H. McGovern, secretary, Chambers of Commerce, Wilmington, Del.

October 10-17.—Eighth annual foundry and machine exhibition in the International Amphitheater Bldg., Chicago, Ill. This exhibit, which was started eight years ago to show foundry equipment only, has broadened out considerably in the past few years and now includes all classes of machine tools and shop equipment as well as foundry equipment and supplies. One hundred and eight concerns were represented in the exhibition held in Buffalo, N. Y., last year and over one hundred and twenty-five concerns have taken space for this year and two hundred are expected. C. E. Hoyt, secretary, Lewis Institute Bldg., Chicago, Ill.

October 13-17.—Annual convention of the American Institute of Metals at Chicago, Ill. W. M. Corse, secretary, Lumen Bearing Co., Buffalo, N. Y.

October 14-16.—Annual convention of the Allied Foundrymen's Association. Hotel La Salle, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 19-25.—Seventh annual convention of the National Society for the Promotion of Industrial Education, in Grand Rapids, Mich. The convention promises to be the greatest yet held by the society in point of attendance, importance of questions to be discussed and interest in the work. C. A. Prosser, secretary, 105 East 22nd St., New York City.

October 20-26.—Convention of the American Mining Congress in Horticultural Hall, Philadelphia, Pa. James F. Callbreath, secretary, Munsey Bldg., Washington, D. C.

October 22-24.—Twelfth annual convention of the National Machine Tool Builders' Association, New York City. Hotel Astor, headquarters. James H. Herron, general manager, Cleveland, Ohio.

October 28-30.—Pennsylvania Industrial Welfare and Efficiency conference in the Capitol Bldg., Harrisburg, Pa., under the auspices of the Engineers' Society of Pennsylvania, Harrisburg, Pa. In connection with the convention an engineering exhibit will be held October 27-31 in the concrete building of the Harrisburg Railway Co. containing 26,000 square feet floor space. Paul Gendell, director of exhibits, Harrisburg, Pa.

December 3-6.—Annual meeting of the American Society of Mechanical Engineers. Headquarters Engineers Bldg., 29 W. 39th St., New York City. Calvin W. Rice, secretary.

December 11-20.—First International Exposition of Safety and Sanitation under the auspices of the American Museum of Safety, 29 W. 39th St., New York City. Dr. William H. Tolman, director. Safety and health in every branch of American industrial life—manufacturing, trade, transportation on land and sea, business and engineering, in all of their subdivisions, will be represented at this exposition. Exhibits from Europe and other foreign countries will be admitted free of duty by special act of Congress. European employers have cut their accident and death rate in half by a persistent campaign of safety. There are twenty-one museums of safety in Europe, and all these will contribute to the American Exposition.

NEW BOOKS AND PAMPHLETS

Metallographic Testing. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 42 of the Bureau of Standards.

Standard Analyzed Samples—General Information. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 25 of the Bureau of Standards.

Analyzed Irons and Steels—Methods of Analysis. 15 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 14.

Analyzed Iron and Manganese Ores—Methods of Analysis. 27 pages, 7 by 10 inches. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 26.

United States Government Specification for Portland Cement. 28 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as Circular No. 33.

Dehydration of Clays. By G. H. Brown and E. T. Montgomery. 23 pages, 7 by 10 inches. Diagrams. Published by Department of Commerce, Bureau of Standards, Washington, D. C., as Technologic Paper No. 21.

Vitrified Brick as a Paving Material for Country Roads. By Vernon M. Peirce and Charles H. Moorefield. 34 pages, 6 by 9 inches. Illustrated. Published by the U. S. Department of Agriculture, Washington, D. C., as Bulletin No. 23.

Determination of Sulphur in Illuminating Gas. By R. S. McBride and E. R. Weaver. 46 pages, 7 by 10 inches. Illustrated. Published by Department of Commerce, Bureau of Standards, Washington, D. C., as Technologic Paper No. 20.

Typical Specifications for the Fabrication and Erection of Steel Highway Bridges. By the Office of Public Roads. 25 pages, 6 by 9 inches. Published by the U. S. Department of Agriculture, Office of Public Roads, Washington, D. C., as Circular No. 100.

New Calorimetric Resistance Thermometers. By H. C. Dickinson and E. F. Mueller. 12 pages, 7 by 10 inches. Illustrated. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as reprint No. 200 from the Bulletin of the Bureau of Standards, Vol. 9.

Note on Cold-Junction Corrections for Thermocouples. By Paul D. Foote. 13 pages, 7 by 10 inches. Diagrams. Published by the Department of Commerce, Bureau of Standards, Washington, D. C., as reprint No. 202 from the Bulletin of the Bureau of Standards, Vol. 9.

Proceedings of the First Cooperative Safety Congress. 336 pages, 6 by 9 inches. Published by the National Congress for Industrial Safety, 2135 Green St., Harrisburg, Pa. The first Safety Congress was held under the auspices of the Association of Iron and Steel Electrical Engineers in Milwaukee, Wis., September 30-October 5, 1912.

Boiler Construction. By Frank B. Kleinhans. 462 pages, 5½ by 7¾ inches. 334 illustrations and five folding plates. Published by Norman W. Henley & Son, New York City. Price $3.

The first edition of this work was published several years ago; the second revised and enlarged edition has just been published. It undoubtedly is one of the best books of the kind in print, starting with the laying out of the sheets and concluding with the completed boiler. The contents comprise laying out work, flanging and forging, punching, shearing, plate planing, bending, machining parts, boiler details, assembling and calking, finishing parts, boiler shop machinery, general tables, plates showing types of modern locomotive boilers, locomotive boiler inspection and questions and answers on boiler inspection.

The Polytechnic Engineer. Vol. XIII. 138 pages, 6 by 9 inches. Published annually by the students of the Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

The 1913 volume of this interesting annual contains the following articles: An Historical Sketch of the Early Development of Bridge Building, by Clarence W. Hudson; Thickness of Films of Silver Upon Glass, by Irving W. Fay and Arthur C. Rauchfuss; Lattice Bars, by George W. Oxley and Edward J. Squire; The Vector Diagrams of Electric Discharges, by Monroe George Woolfson; Senior Inspection Trip, by John H. Husing; The Diffusion of Light by Mechanical Means, by Louis A. Rosett; The Pitot Tube, by H. P. Hammond; Chinese Wood Oil, by Everitt J. Cole; Engineering Education Today in America and the Place of the Polytechnic among Colleges of Engineering, by William D. Ennis; A Resume of the Lectures of Sir William Ramsay, by Henry W. Sheff; The Predetermination of the Voltage—Regulation of Alternators, by Sampson K. Barrett.

Shop Mathematics. Part II. By Earle B. Norris and Ralph T. Craigo. 214 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York City. Price $1.50 net.

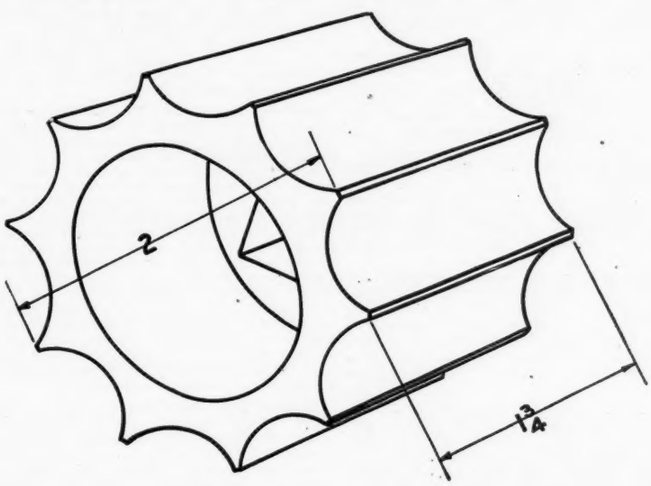
This work on advanced shop mathematics is a second half of the instruction papers developed and used in the University of Wisconsin. It presents the principles of algebra, geometry, trigonometry and logarithms with the intention of making them of practical value in shop work. The contents by chapter heads are: Formulas; Explanation of Terms—Algebraic Addition; Algebraic Subtraction; Transformation of Formulas; Algebraic Multiplication and Division; Solution of Simple Equations; Simultaneous Equations—Quadratic Equations; Tables and Curves; Equations of Curves; Geometric Constructions; Construction and Properties of Geometric Figures; Areas of Geometric Figures; Volumes and Surfaces of Solids; Trigonometry—the Tangent and Cotangent; Some Uses of the Tangent and Cotangent; the Sine, Cosine, Secant and Cosecant; Screw Threads and Spirals; Solution of Triangles; Logarithms; Logarithms of Decimals, Powers and Roots. The work is gotten up in excellent typographical style. The principles and problems are illustrated with good drawings, and the work as a whole is one that can be recommended to ambitious practical men generally, bent on improving their condition by home study.

Dyke's Automobile Encyclopedia. By A. L. Dyke. 557 pages, 6½ by 10 inches. Illustrated. Published by A. L. Dyke, St. Louis, Mo. Price $3.

This work is in forty parts and contains 239 charts with a dictionary and index. It treats of the construction, operation and repair of automobiles and gasoline engines in a very thorough and effective manner, covering the subjects more thoroughly probably than any other published work at the price. The titles of the subjects treated are: The Car Complete; Drives; Steering, Springs, Brakes; Axles, Differential; Clutches; Transmissions or Change Speed Gears; Gasoline Engine; Engine Parts; Valve Timing; Engine Balance, How Cylinders Fire; Explanation of the Two "Cycle" Principle; Carburetion; Self Starters; Electric Ignition—Low Tension Coil; High Tension Coil Systems; Wiring and Connections; Ignition Timing; Various Ignition Systems; Low Tension Magnetos; High Tension Magnetos; Principle and Construction of Magnetos; Magneto Wiring Diagrams; Magneto Setting and Troubles; Storage Batteries and Power Lighting; Cooling; Lubrication; Car Operation; Rules of the Road; Care of Cars; Tires; Vulcanizing; Garages and Repair Shops; Equipment, Tools and Use of Tools; Repairs and Adjustments; Digest of Troubles, Diagnosis and Remedy; Insurance, Laws; Horsepower, Tables, Measurements; Steam Cars, Air Craft; Pointers for Automobile Salesmen; Dictionary, Index.

IF YOU MANUFACTURE IN LARGE QUANTITIES

and if in the range of your work there is a piece which resembles this—

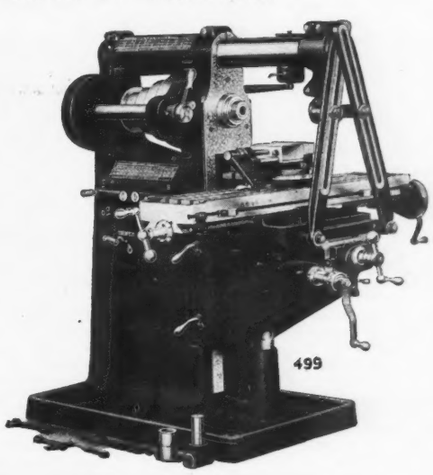


Time for all 10 grooves:

1.3 minutes

you ought to be interested in the "CINCINNATI" method of milling, which enables one of our customers to finish to gauge the ten grooves of this *grey iron seed roll in 1.3 minutes.*

This — the total time for complete operation — includes chucking, adjusting and removing. That's equivalent to continuously milling at the rate of 17½ inches per minute with *no rest period for the machine.*



We build 'em for this kind of service. This work is being done on our No. 2 Plain Cone Driven Machine.

It's not an expensive Single Pulley Miller. Neither is it the cheapest kind of Manufacturing Machine.

It represents what we believe to be the most suitable type of machine for this work and one that will give the most output per dollar of investment.

We want to give all details to those who are interested.

If you are one, write our Time Study Department.

They'll gladly take up *your own milling* propositions.

Better let them figure out cost-reducing methods on your work.

The Cincinnati Milling Machine Co.

CINCINNATI, OHIO, U. S. A.

Rules of Management. By William Lodge. 139 pages, 5 by 7½ inches. Published by McGraw-Hill Book Co., New York City. Price $2 net.

The principles of management laid down in this book are exemplified in the management of the Lodge & Shipley Machine Tool Co., of Cincinnati, Ohio, of which Mr. Lodge is president. The book is unique, being virtually a compilation of the rules and practice of the company, which is a well-known manufacturer of lathes. The contents by chapter heads are: The Exceptional Employe, The General Manager, Chief Engineer and Designer, Drawing-room, Purchasing Agent, Incoming Material and Stores Department, Superintendent of Manufacture, Routing Department, Chief Clerk, Cost and Time-keeping Department, Operation of Premium Plan, Superintendent of Assembly, Handling Complaints, Pattern Shop, Tool-making Room, Forge Department, Lathe Department, Grinding Department, Drilling Department, Planer Department, Milling Department, Gear Cutting Department, Special Manufacturing Department, Inspecting Department, Specific Instructions for Painting Lathes, Sales Manager, Shipping Clerk, Boss Laborer and Express Truckman, Millwright and Belt Man, Engineer, Electrician and Oiler, Janitors and Watchman, A Proposed Pension Plan and Basis on which a Fund can be Started. The work is one that should interest and instruct all concerned in any way with the superintendence or management of manufacturing plants and especially those connected with the building of machine tools.

NEW CATALOGUES AND CIRCULARS

Standard Tool Co., Cleveland, Ohio. Catalogue No. 21 on drill chucks.

S. E. Parker, Chicago, Ill. Catalogue No. 26 on hoisting machinery.

Yale & Towne Mfg. Co., 9 E. 40th St., New York City. Leaflet on the Yale all-steel triplex block.

Asbestos Protected Metal Co., Beaver Falls, Pa. Bulletin No. 53 on asbestos steel for roofs and walls.

Whitman & Barnes Mfg. Co., Akron, Ohio. Folder on "W. & B" screw and drop-forged wrenches.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, Ill. Bulletin No. 148 on hand drills and portable air compressors.

Cling Surface Co., 1018 Niagara St. Buffalo, N. Y. Report of comparative tests of belts with and without "Cling Surface."

Brown Instrument Co., Philadelphia, Pa. Bulletin containing a large number of testimonial letters received from users of Brown electric pyrometers.

George G. Dana, 2311 Washington Ave., Racine, Wis. Circular of the Dana duplex spring clips for holding drawings, tracings, blueprints and similar materials.

American Museum of Safety, 29 W. 39th St., New York City. Pamphlet on safety including the conditions of competition for the E. H. Harriman memorial gold medal, etc.

Millers Falls Co., 28 Warren St., New York City and Millers Falls, Mass. Circulars of "Star" hacksaw frames, sill borer or joist tools, hand and breast drills, chain drills, etc.

Kennicott Co., Chicago Heights, Ill. Little Journey to the Kennicott Co., by Elbert Hubbard, describing the ideals, aims and business of the concern, and written in characteristic Hubbard style.

Green, Tweed & Co., 109 Duane St., New York City. Booklet illustrating a number of large, well-known buildings in New York City whose engine rooms are fitted with "Rochester" automatic lubricators.

Quigley Furnace & Foundry Co., 25 Church St., New York City. Bulletin No. 2 on the continuous revolving shelf or reel type core ovens, burning coal, coke, oil or gas fuel, for baking small and medium size cores.

C. G. Garrigus Machine Co., Bristol, Conn. Circular of No. 2 Bristol hand milling machines, a machine especially adapted for keyseating, hobbing worm gears, profiling, cam cutting, and other characteristic hand milling machine work.

F. W. King Optical Co., Cleveland, Ohio. Circular on the King "I-Safe" goggle for workmen in shops, mills and factories. Special forms with colored glass are offered for open-hearth steel workers, oxy-acetylene welders, etc.

Skinner Chuck Co., New Britain, Conn. Catalogue and price list of independent, universal and combination lathe chucks, drill chucks, planer chucks, faceplate jaws, drill press vises, reamer stands, precision drawing-in chucks, etc.

Edge Moor Iron Co., Edge Moor, Del. Bulletin 51, entitled "Tests of a Steam Boiler at High Rates of Evaporation," describing tests made at the Westport generating station of the Consolidated Gas Electric Light & Power Co., of Baltimore.

Fosdick Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing heavy-duty type of round column radial drill, being the first of a complete line of round column radial drills which will be added to the company's regular line of box column radials.

Standard Electric Tool Co., Cincinnati, Ohio. Bulletin D-9 and DA-10, superseding D-8 and D-9, respectively on "Standard" high-power direct-current portable electric drills and "Standard" high-power two- and three-phase alternating-current portable electric drills.

Diamond Machine Co., Providence, R. I. Catalogue of the "Diamond" heavy face and guide bar grinding machine, illustrating details of construction fully. The machine embodies some interesting features of design, especially in table tripping and reversing mechanism.

Oneida National Chuck Co., Oneida, N. Y. Circular on the "National" safety lathe dog having no projections, driving arms or exposed set-screws to injure workmen or tear clothing. This safety lathe dog is offered in response to the demand for a greater safety in engine lathe operations.

De Laval Steam Turbine Co., Trenton, N. J. Booklet entitled "Improved Methods of Connecting Small Turbines in Steam Power Plants and Exhaust Heating and Drying Systems," describing several methods of connecting small turbines for driving auxiliaries in large steam power plants, etc.

Racine Electric Co., corner Prospect and Superior Sts., Racine, Wis. Catalogue A of "Racine" universal motor specialties, including high-speed electric grinders, driving grinding wheels at 14,000 R. P. M., high-speed lathe center grinders, universal electric portable grinder, desk and table fans, etc.

Rice Gasoline Rock Drill Co., 1510 Land Title Bldg., Philadelphia, Pa. Bulletin on the Rice gasoline rock drill, which is said to be the only free piston gasoline rock drill. The machine is entirely self-contained, consisting of gasoline drill, tripod, fuel and lubricant container, ignition battery and water tank.

Welles Caliper Co. (associated with A. J. Machek & Co.), 305 Twenty-fourth St., Milwaukee, Wis. Catalogue of Welles calipers and machinists' tools, comprising firm joint calipers, hermaphrodite calipers, adjustable calipers, hermaphrodite calipers and dividers with inserted points, steel rules, precision bench shears, tubular micrometer frames, etc.

Ingersoll Milling Machine Co., Rockford, Ill. Bulletin No. 34 R. F. on fixed-rail milling machines for manufacturing purposes. The bulletin illustrates a variety of designs of fixed-rail milling machines built by the company for various manufacturing establishments; it also shows illustrations of work in process of being machined.

Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Rail Reports Bulletin No. 2 on rails made of open-hearth steel, giving physical tests and chemical analysis of standard open-hearth rails and titanium open-hearth rails, photographs of sections, sulphur prints, etc. These rail reports contain valuable data for railway officials and all concerned with maintenance-of-way.

Sprague Electric Works of the General Electric Co., 527-531 W. 34th St., New York City. Bulletin No. 850 on industrial ozonators for ventilation and air purification and water purification. The effect of the industrial ozonators on industries such as fertilizer work, slaughter houses, etc., probably will be revolutionary. Such industries apparently can be made as innoxious as any other enterprise.

Skinner Chuck Co., New Britain, Conn. Circular of the Jarvis precision draw-in chuck for straight, concentric and eccentric work. The chuck is made in three sizes ranging in capacity up to 1½ inch. When used as an eccentric chuck it can be thrown 0.250 inch off center. Any degree of eccentricity between 0 and 0.250 inch can be obtained without measurement by using the dial adjustment.

Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, Ohio. Bulletins Nos. 13 and 14 on electric welder data and electric butt welders. These bulletins illustrate a variety of electric welding machines and examples of electric welding. They give elementary welding information, instructions for operating welding data and other useful data for users of welding machines.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue of Canton alligator shears, illustrating five sizes having capacity from 1½ inch square in machinery steel or iron to 3 inches square, inclusive. These alligator shears are built with either motor or belt drive. Besides the regular styles, the company builds high-knife and stop motion alligator shears of various sizes; also portable motor driven shears in the No. 1 size only.

Hess-Bright Mfg. Co., 17 E. Erie Ave., Philadelphia, Pa. Data sheets on adjustable mounting for automobile bevel driving pinion and gear and ball bearing on vertical spindle of matching machine. These data sheets illustrate the recommended mounting practice for Hess-Bright annular ball bearings in the designs mentioned and are uniform in style and size with data sheets previously published, illustrating a great variety of ball bearing designs.

Philadelphia Steel & Forge Co., 50 Church St., New York City. Circular on the products manufactured, including automobile steel, alloy steel, axe and hatchet steel, ball bearing steel, bit and jar steel, bevel shapes, car axles, cutlery steel, connecting rods, clover brand tool steel, crankshafts, die blocks, drill steel, forged bars and shapes, file and rasp steel, gear blanks, locomotive forgings, magnet steel, nickel steel, rings, spring steel, spindles, shafts, etc.

Superior Tap Co., Charlestown, N. H. Catalogue of taps, dies and screw plates, including machinists' screw plates, machine screw taps, machinists' hand taps, machine or nut taps, pulley taps, tapper taps, patch bolt taps, blacksmiths' taper taps, straight and taper boiler taps, Beaman & Smith taps, stove bolt taps, long hobs or master taps, short hob taps, Sellers' hob taps, staybolt taps, pipe taps, hobs and reamers, combined pipe tap and drill, mud plug taps, round and adjustable dies, machine or solid bolt dies, solid square pipe dies, "Superior" screw plates, blacksmiths' stocks and dies, etc.

Engrenages Citroen Societe Anonyme, 31 Quai de Grenelle, Paris, France. Catalogue of Citroen gears, containing a history of the development of the system, illustrations of large spur and bevel types, rolling mill pinions, etc. The Citroen gear is of the herringbone form but the right- and left-hand helical teeth are integral, being cut on one solid rim; the junctures between the right- and left-hand helices are effected in curves of short radii. In wide-face large gears there is a double reversal of helix, making in substance, two herringbone gears in one. The result is very smooth tooth action. Also pamphlet of testimonial letters from users of Citroen gears illustrated with notable examples of gears furnished.

Baldwin Locomotive Works, Philadelphia, Pa. Baldwin booklet issued in commemoration of the completion of the forty thousandth locomotive built by the company. The Baldwin Locomotive Works has been in continuous operation for eighty-two years. The first locomotive was completed in 1832. The forty thousandth locomotive is one of thirty similar engines built for the Pennsylvania Lines West of Pittsburg and designated as class K-3-S. It is of the "Pacific" type, having three pairs of driving wheels, a four-wheeled leading truck, and a two-wheeled trailing truck. The cylinders are 26 by 26 inches; steam pressure, 205 pounds per square inch; grate area, 55.4 square feet; water-heating surface 3680 square feet; weight on driving wheels, 189,500 pounds; total weight of locomotive, 293,200 pounds; tractive force, 38,300 pounds. The booklet contains a number of illustrations showing the development of American locomotives.

National-Acme Mfg. Co., Cleveland, Ohio. Catalogue of the "Acme" automatic multiple-spindle screw machines. This catalogue, which is of the standard letter size, 8½ by 11 inches, is the most comprehensive and complete that has ever been issued by this company, and is a beautiful example of typographical work. The catalogue is divided into several sections, such as construction and operation of the machine, different sizes and styles of machines, attachments for saving time or doing extraordinary operations, chucks, cams, tools and product. It is replete with halftone illustrations and contains a large number of small line illustrations showing the operating mechanism in detail. The supplementary text describes the chief mechanical features. Superintendents, foremen and operators interested in screw machines and screw machine practice generally should possess a copy of this latest catalogue, as it contains the very latest developments in this type of multiple-spindle screw machine.

TRADE NOTES

King Machine Tool Co., Cincinnati, Ohio, manufacturer of boring mills, has just completed a large addition to its plant. The company reports a rapidly increasing business.

Hoefer Mfg. Co., Freeport, Ill., has appointed the J. R. Stone Tool & Supply Co., 24 Goebel Bldg., Detroit, Mich., agent for the Hoefer line of auxiliary heads in Michigan territory.

Bury Compressor Co., Erie, Pa., has begun the erection of an addition to its plant extending the main building 100 feet. The addition is necessary to take care of the company's increasing business.

Metal Treating and Equipment Co., Inc., 1784 Broadway, New York City, has opened a plant at 834 Humboldt St., Brooklyn, N. Y., to do job galvanizing work by an improved process of electro-galvanizing.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York City, has opened a new office and warehouse in Galveston, Tex. The company now has three offices in the state of Texas, at Houston, Dallas and Galveston.

Ready Tool Co., 654 Main St. Bridgeport, Conn., has appointed the J. R. Stone Tool & Supply Co., direct manufacturers, representative of "Red-E" tools and "Red-E Hill" line of machine dogs for the state of Michigan and the northwestern part of Ohio.

Philadelphia Steel & Forge Co., Tacony, Philadelphia, Pa., has installed a new power plant in its rolling mill department which will increase its tonnage of finished bars 2000 tons per month. The company has also installed a heat-treating plant, and is specializing on high-grade steels for automobiles, locomotives, machine tools, etc.

Beaudry & Co., Inc., Boston, Mass., has perfected a direct-connected motor drive for the "Beaudry Champion" and "Peerless" power hammers, and descriptive circular matter will soon be ready for distribution. The company has arranged to carry a complete stock of motor-driven hammers in addition to the belt-driven hammers which they have marketed for years.

W. H. Leland & Co., Worcester, Mass., has appointed Mr. Stanley B. Dowd, formerly manager of the machinery and supply department of the Fairbanks Co., Boston, as its exclusive selling

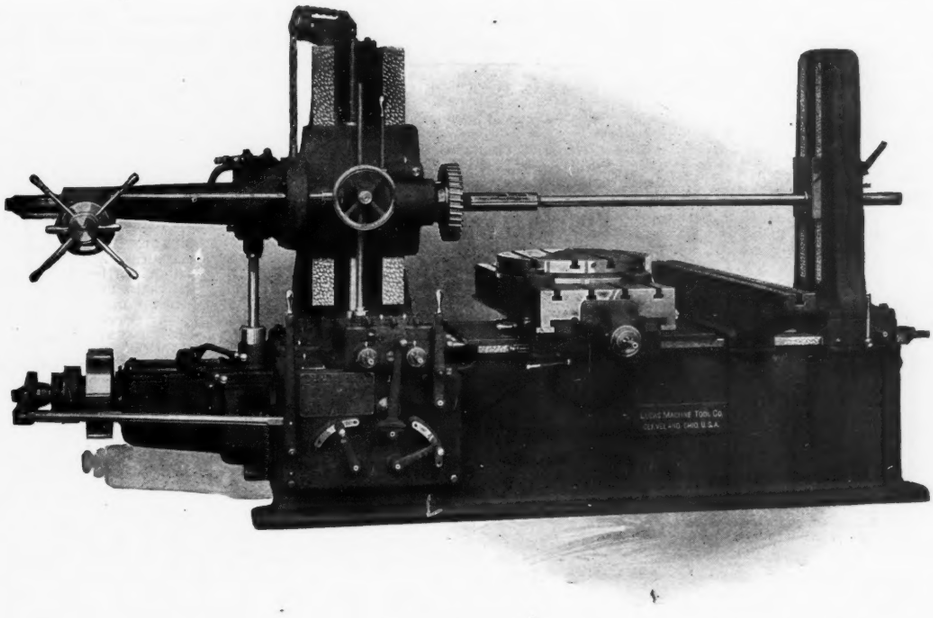
A Prospective Customer for a

"PRECISION"

Boring, Drilling and Milling Machine

SAID:

"What are your Talking Points?"
To which we replied that we have no talking points,
the machine talks for itself.



We prefer to sell SATISFACTION and not talking points, because we want to sell you or your neighbors or your inquiring friends MORE THAN ONE machine in the long run.

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF **CLEVELAND, O., U.S.A.**

AGENTS: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, St. Petersburg, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada. H. W. Petrie, Ltd., Toronto, Ont.

representative in Boston territory. Mr. Herbert P. Sawtell will represent the company as exclusive selling agent throughout New England territory, except in Connecticut and Boston, having headquarters in Worcester.

Colonial Steel Co., Pittsburg, Pa., has installed a complete plant for the hardening and tempering of tools in its Chicago warehouse. The plant is operated under the supervision of an experienced tool hardener, and is prepared to harden and temper all kinds of tools made from either high-speed or carbon tool steel for users of "Colonial" steel. The plant is similar in equipment to its Boston warehouse, 84 High St., the work of which has been highly appreciated by the trade served.

Acklin Stamping Co., 1645-1653 Door St. Toledo, Ohio, has erected a large warehouse and shipping room to take care of increased business. The new building is of modern construction, and is equipped throughout with appliances for the rapid and economical handling of sheets and bar metal used in the manufacture of various stampings required by the customers of the company. The new building affords storage facilities for about 1500 tons of metal. By carrying so large a stock the company is able to meet the requirements of its customers promptly.

Vulcan Engineering Sales Co., Fisher Bldg., Chicago, Ill., manufacturers of riveters, molding machines, metal saws, traveling cranes, etc., will exhibit products of its constituent companies; viz., Mumford Molding Machine Co., Q. M. S. Co., Hanna Engineering Works and Vulcan Engineering Sales Co., at the Foundry and Machine Exhibition, in Chicago October 10-17. Between forty and fifty tons of machines and appliances will be shown, the greater portion of which will be in operation. The Mumford exhibit will occupy 1600 square feet of floor space in Section 501-508 inclusive.

Terry Steam Turbine Co., Hartford, Conn., has supplied two Terry turbine forced-draft blower sets which are probably the largest in point of horsepower in the world. These sets are to be installed at the Rhode Island Co.'s power plant in Providence, R. I. Each unit consists of a 600 H. P. turbine driving through a set of Falk reduction gears an American Blower Co.'s "Sirocco" blower. Each unit has a capacity of 250,000 cubic feet per minute and supplies draft to mechanical stokers. The turbines run at a speed of 3370 R. P. M., and the blowers at 460 R. P. M., the speed reduction being 7.35 to 1.

Kidder-Oswald Co., Dayton, Ohio, is the outcome of the complete reorganization of the Noyes Mfg. Co. The capital stock has been increased to $250,000. The officers are Walter S. Kidder, president; J. A. Oswald, vice-president and general manager; George C. Kaefer, secretary. The company's buildings and grounds which were damaged by the recent flood have been completely restored and many improvements have been made. The company will continue to manufacture contracts, specializing in the manufacture of die castings, machined parts, and stampings, dies, jigs, tools, fixtures, special machinery tool models, etc.

American Pulley Co., Philadelphia, Pa., manufacturer of steel split pulleys, has increased its capacity by erecting another large building containing 54,000 square feet and having a storage capacity of 40,000 belt pulleys. The building will also be devoted to the storage of sash pulleys, bushings and all finished products. The entire structure is fire-proof. It has brick walls, tile roof, concrete floors, metal racks, metal bins and shelving and metal window frames. The rapid growth of the company during the past thirteen years is indicated by the fact that this new building contains more floor space than the entire plant in 1900.

Hess Steel Castnigs Co., Withspoon Bldg., Philadelphia, Pa., and Bridgeton, N. J., has practically perfected the manufacture of the purest wrought iron obtainable into castings. The pure material produces castings of great ductility, density, solidity and uniformity. They are particularly adapted for parts of electrical equipment where high magnetic permeability is essential and for purposes where castings have to withstand corrosion, high pressure and high temperature, successive heatings and coolings, etc. They are well suited for casehardening boxes, cyanide and lead pots, smelter castings, etc., for intricate designs and for parts that have to withstand severe strains and shocks.

Cincinnati Pulley Machinery Co., Cincinnati, Ohio, manufacturer of the "Avey" high-speed drill, is erecting a new factory on Third St., Covington, Ky. (across the Ohio River from Cincinnati) which will be ready for occupancy about the middle of November. The new building will have two stories and basement and will be 50 feet wide by 180 feet long. It will be constructed of brick, and when equipped with new machinery will have about double the capacity of the old plant which was destroyed by fire some months ago. The building will occupy only about one-third of the plot which extends through the entire block, thus affording plenty of space for future growth. Since the destruction of the old plant the company has been occupying temporary quarters on Madison St., Covington.

Miscellaneous Advertisements—Situations, Help Wanted, For Sale, etc.

Advertisements in this column, 20 cents a line, seven words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

HARDENING and METAL TREATING.—C. U. SCOTT, Davenport, Iowa.

TEST INDICATORS.—H. A. LOWE, 1374 East Eighty-eighth St., Cleveland, Ohio.

WELLES TOOLS are different. Get a catalogue and price list. WELLES CALIPER COMPANY, Milwaukee, Wis.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

BOOKS.—"Dimensions of Pipe, Fittings and Valves," seventy-five cents. "Structural Drafting," $1.00. Both $1.50. NATIONAL BOOK CO., Collinwood, Ohio.

PATENTS SECURED. — C. L. PARKER, Ex-member Examining Corps U. S. Patent Office. Instructions upon request. 900 G St., N. W., Washington, D. C.

TWO TOOLMAKERS desire to connect with reliable firm manufacturing interchangeable parts. Address Box 589, care MACHINERY, 49 Lafayette St., New York.

GENERAL MACHINERY DESIGNED, working drawings and tracings furnished. Inventions developed; rates moderate; prompt attention. SAMUEL GOODMAN, 21 Park Row, New York.

AUTOMATIC AND SPECIAL MACHINES designed. Working drawings. Tracings. Special Tools and Fixtures designed. C. W. PITMAN, 3519 Frankford Ave., Philadelphia, Pa.

WANTED. — MACHINE SHOP FOREMAN by large automobile factory. Address Box 590, care MACHINERY, 49 Lafayette St., New York, stating age, experience and salary expected.

FOR SALE.—One Potter & Johnston 6A-Automatic Chucking Machine. Bought 1910. Used but little, good as new. $1000 cash. PARKS & WOOLSON MACHINE CO., Springfield, Vt.

FOR SALE.—5748 steel tubes ⅝" O. D., No. 16 Gauge, 20 inches in length. 5680 steel tubes ⅝" O. D., No. 16 Gauge, 16 inches in length. All in perfect condition. Address Box 569, care MACHINERY, 49 Lafayette St., New York.

WANTED.—PRACTICAL TOOL AND JIG MAKER who can design simple labor-saving tools and jigs; to be assistant to superintendent on cost reduction work; permanent position with chance to advance. CURTIS & COMPANY MFG. CO., St. Louis, Mo.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

WANTED. — Toolmakers', machinists' attention. Complete and surprising features in our newly issued circular (No. 3), on Boulet's Universal Micrometer Test Indicator. Write today to BOULET'S FINE TOOL WORKS, Sebago Lake, Maine.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact cost. Send for full information. Trade-marks registered.

WANTED.—MAN TO ACT AS ASSISTANT FOREMAN in machine shop. Must be familiar with modern machine shop practice and capable of pushing the repair work through shop. State experience and salary desired. P. O. Box 1537, Philadelphia, Pa.

PATENTS, TRADEMARKS AND LABELS.—Patents secured on patentable inventions; prompt personal service; no charge if patent is not secured; advice and search free. W. EDGAR LEEDY, Patent Lawyer, 223 13th St., S. W., Washington, D. C.

REPRESENTATIVES WANTED in different trade centers to secure contracts for small and medium size machine work on commission basis. Full particulars furnished upon request. THE UNIVERSAL TELEGRAPHIC & MACHINE CO., The Industrial Building, Baltimore, Md.

ERECTOR WANTED.—To install cranes and hoisting machinery throughout the country. Experienced man required. Should be competent machinist, electrician and rigger. Good wages. State qualifications and experience. Address Box 594, care MACHINERY, 49 Lafayette St., New York.

AT A BARGAIN.—LARGE CEMENT PLANT including steel buildings, power plant (Nordberg engines) electric motors, conveyor and other machinery, rotary kilns, etc. Little used. Will be sold as a whole or in parts. For inventory and particulars address SECRETARY, Suite 380, Hudson Terminal, New York.

WANTED.—EXPERIENCED FACTORY SUPERINTENDENT for an Electrical Manufacturing Plant in Canada employing 300 hands. Applicant must be thoroughly familiar with modern methods of production, and competent to handle men. Splendid opportunity for right man. Address Box 592, care MACHINERY, 49 Lafayette St., New York.

ENGINEERS, SUPERINTENDENTS, designers, draftsmen, production engineers, master mechanics, auditors and other high-grade men are invited to file their professional records with us for vacancies now open and in prospect. Only high-grade men whose records can stand investigation need apply. THE ENGINEERING AGENCY, Inc.—20th Year—Chicago.

ELECTRICAL ADVICE.—Managers, factory electricians and mechanical and civil engineers are invited to submit their electrical equipment questions. Distribution problems and motor characteristics a specialty. Nominal charges. Nothing too technical. Graduate engineer. No manufacturing connections. EQUIPMENT BUREAU, Box 337, Anderson, Ind.

Subscribe to INVENTION, Washington, D. C. It suggests and develops ideas to hasten the success of inventors and manufacturers. Only magazine truthfully reporting patent successes, opportunities and news. Publishes big list of valuable opportunities and suggestions; simplifies patent matters; saves money. Year $1.00. Special, Four months 25 cents, Cash.

WE ARE EXCEPTIONALLY WELL FITTED to build your light and medium weight machines on contract in reasonable lots. Can store finished material, shipping direct to consumer your single orders or in lots and take the factory end entirely off your hands. Best of shipping facilities. Prompt and efficient service. High-class workmanship. Prices right. HOYSRADT & CASE, Kingston, N. Y.

WANTED.—TOOLMAKER to take charge of mechanical work in valve shop employing 400 men. Must be familiar with tools for brass and iron valves, and capable of making and repairing tools. Man experienced in handling of help and in foremanship preferred. In replying state if now employed, age and experience. Address Box 588, care MACHINERY, 49 Lafayette St., New York.

MACHINISTS, TOOL AND DIE MAKERS WANTED.—Must be first class, thoroughly experienced mechanics. Also machine hands capable of running lathes, vertical and horizontal boring mills, planers and radial drills. New plant; modern equipments; steady work; fine location. Apply by letter giving age, experience and references. Address Box 595, care MACHINERY, 49 Lafayette St., New York.

POSITION WANTED. — Superintendent or Manager, age 39, preferably in shop with good financial backing, but run down, or new shop. Would, if satisfactory, take part of salary in stock. Advertiser is thorough mechanic; has designed plant and machinery, installed and run same. Automatic press, blanking and redraw, buffing and wire machinery. Address Box 586, care MACHINERY, 49 Lafayette St., New York.

WANTED.—Ten competent mechanical engineers, each to compile 100 data sheets for the Lefax loose-leaf reference library. Work must represent the latest practice, must be thoroughly condensed, suitable for use in the Lefax loose-leaf pocket book. Work to be accepted or rejected on the advice of mechanical engineers of recognized standing. Address STANDARD CORPORATION, Penna. Bldg., Philadelphia, Pa.

FOR SALE.—We have in a town of 11,000 people a fully equipped machine shop and foundry which we wish to dispose of and will make easy payments to a good machinist with a little money if he will get the shop going. It is the only opportunity of the kind in the town. We will not sell any of the machinery piecemeal, as we wish to make this a going business. Address Box 593, care MACHINERY, 49 Lafayette St., New York.

SALES MANAGER. — District Sales Manager wanted by an established Consulting Engineering and Construction Corporation, based on co-operative plan, offices in Cleveland, Detroit, Buffalo and New York City. The position requires a man with engineering knowledge, one who can take full charge of the Sales Department. Highest references and $1000 stock investment required. Contract with salary, commission and interest in business guaranteed. Address "SALES MANAGER," Box 591, care MACHINERY, 49 Lafayette St., New York.

WANTED. — Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say, "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic, valuable information condensed in pocket size. Price post paid $1.00 cloth; $1.25, leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

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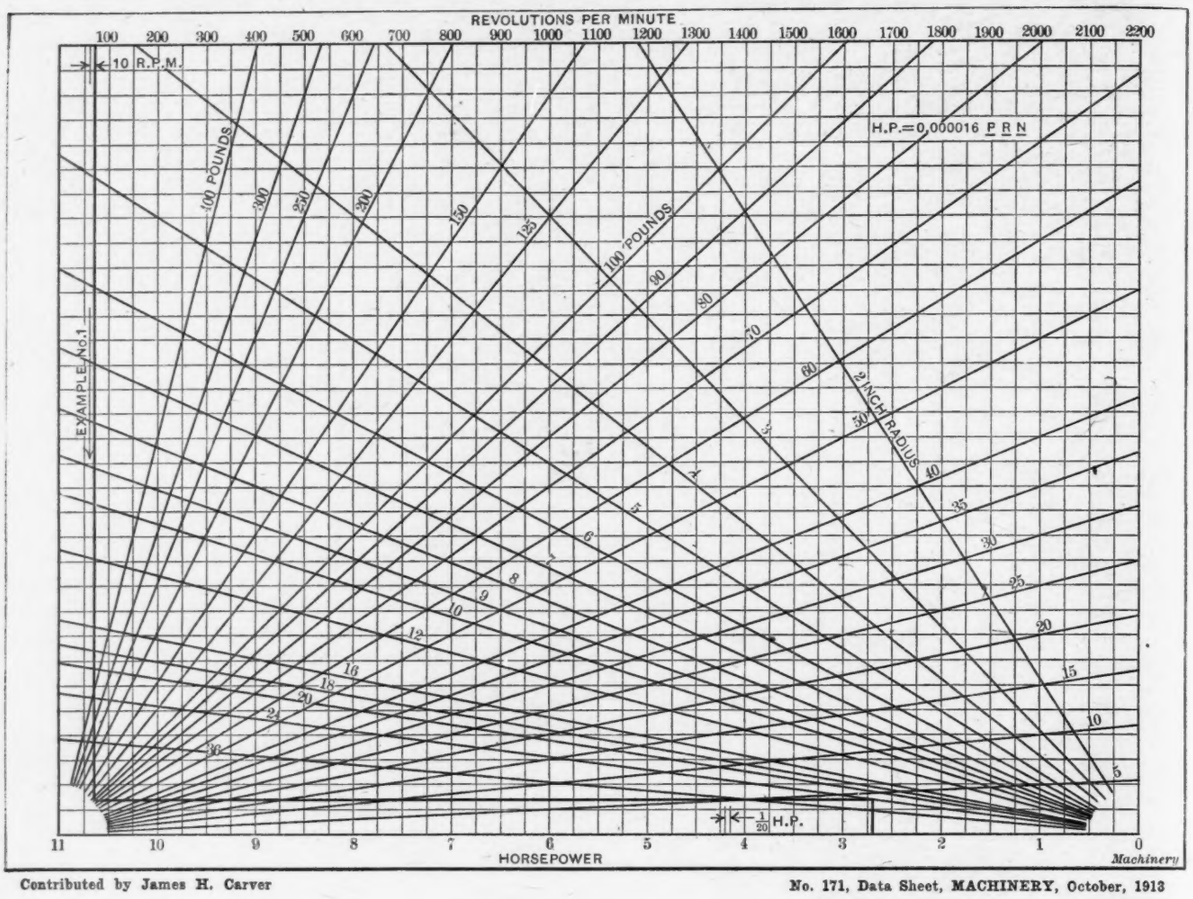
PRONY BRAKE—HORSEPOWER, TORQUE, RADIUS AND SPEED OF ROTATION—I



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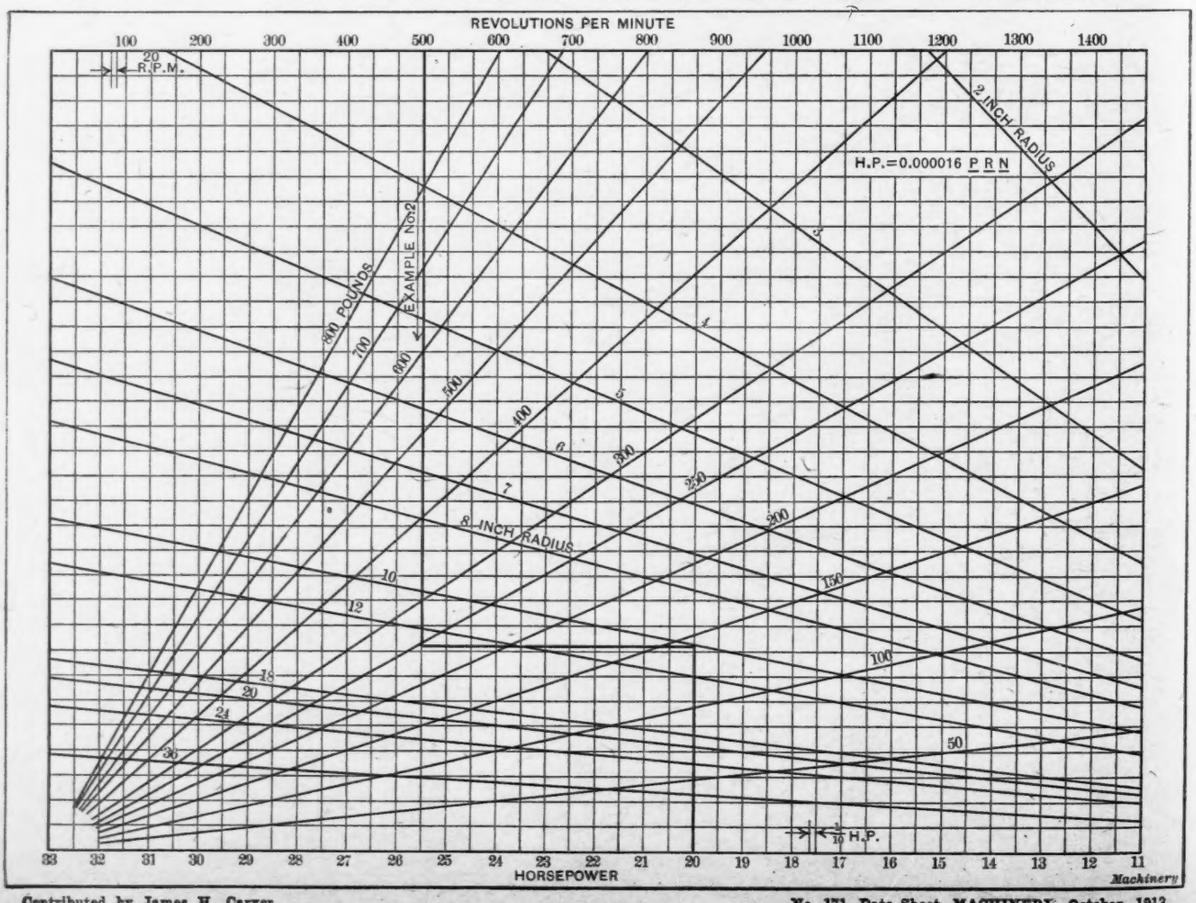
PRONY BRAKE—HORSEPOWER, TORQUE, RADIUS AND SPEED OF ROTATION—II



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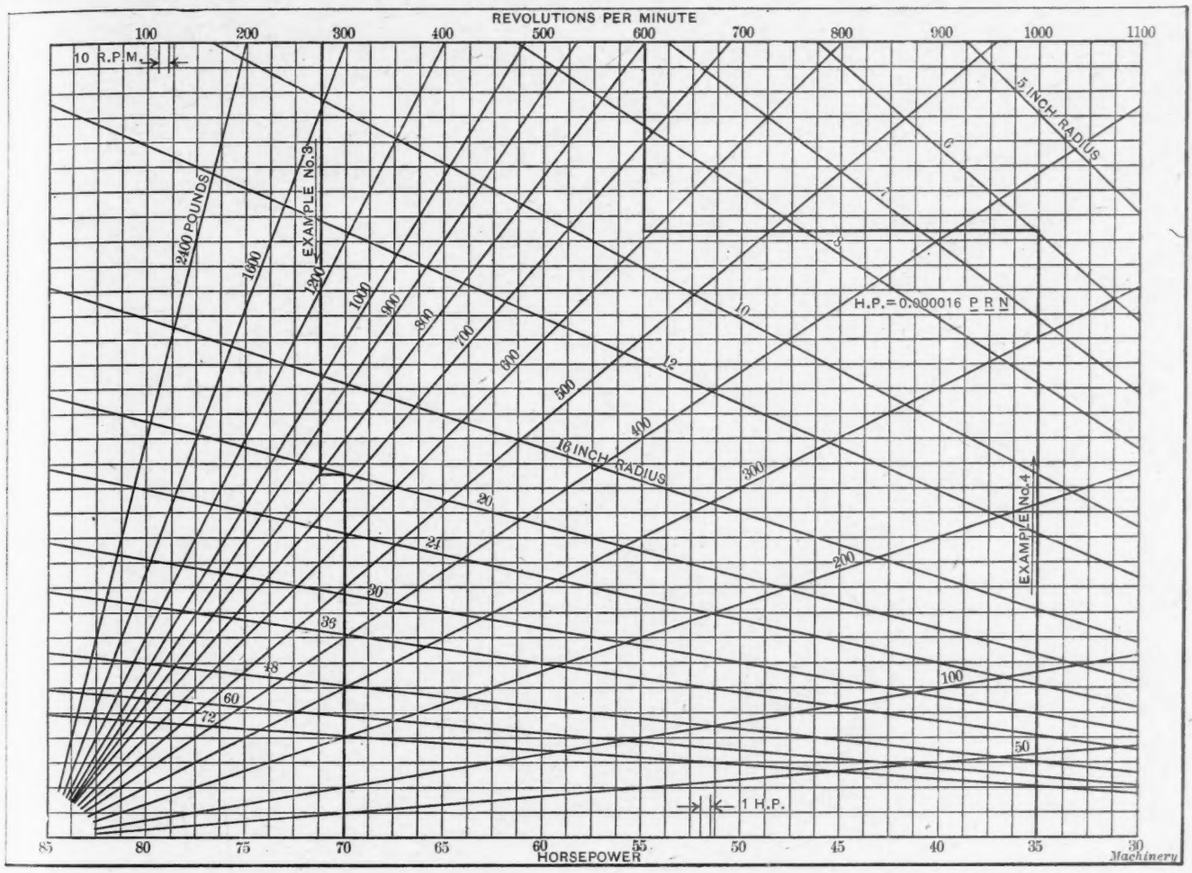
PRONY BRAKE—HORSEPOWER, TORQUE, RADIUS AND SPEED OF ROTATION—III



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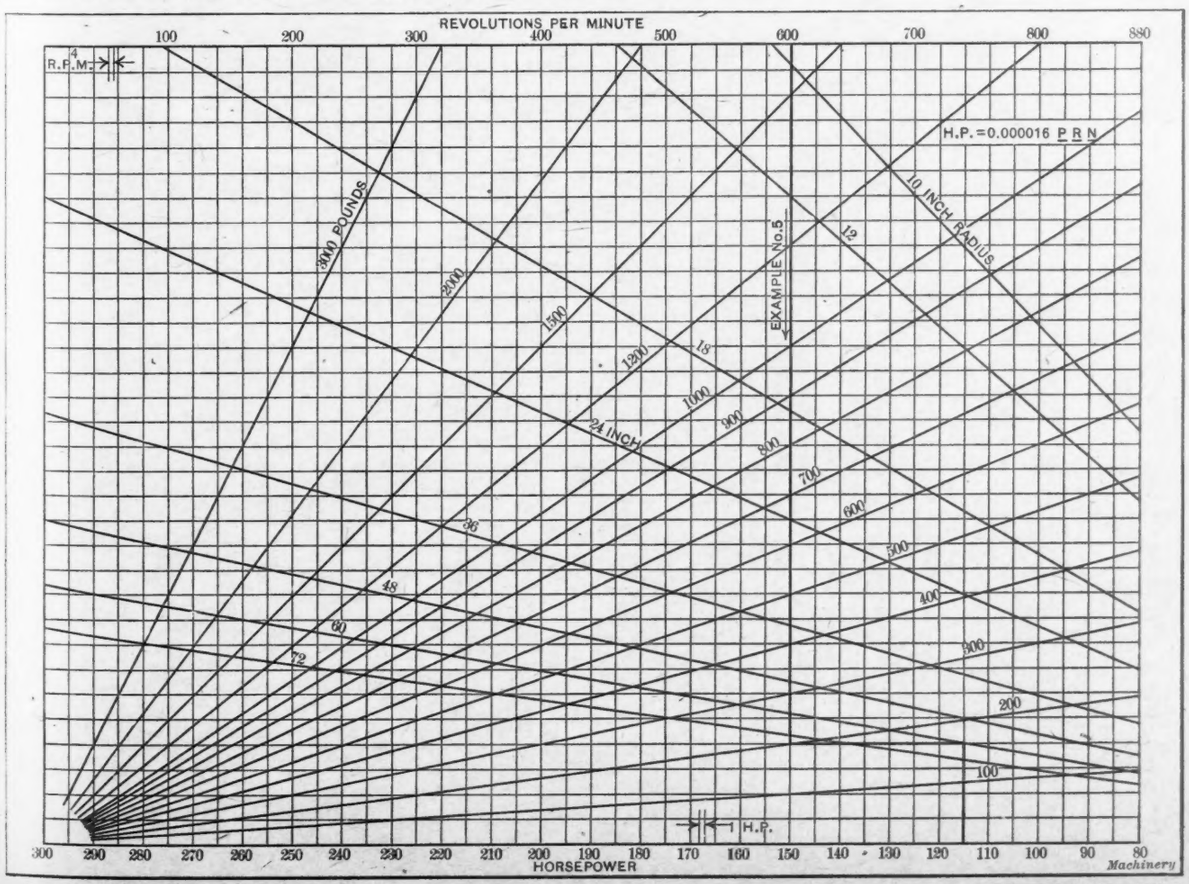
PRONY BRAKE—HORSEPOWER, TORQUE, RADIUS AND SPEED OF ROTATION—IV



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